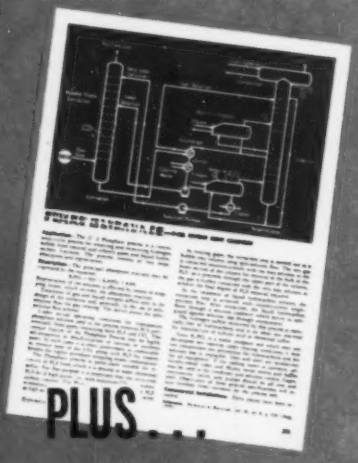
OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

SEPTEMBER
1958

1958 REFINING PROCESS HANDBOOK



PLUS...

85 process descriptions showing flow diagrams

Quick Look at 9 process groups with comparisons

207

A Special Report on Alkylation 316

SHORT CUT

From Flow Sheet to Cost Estimate 331

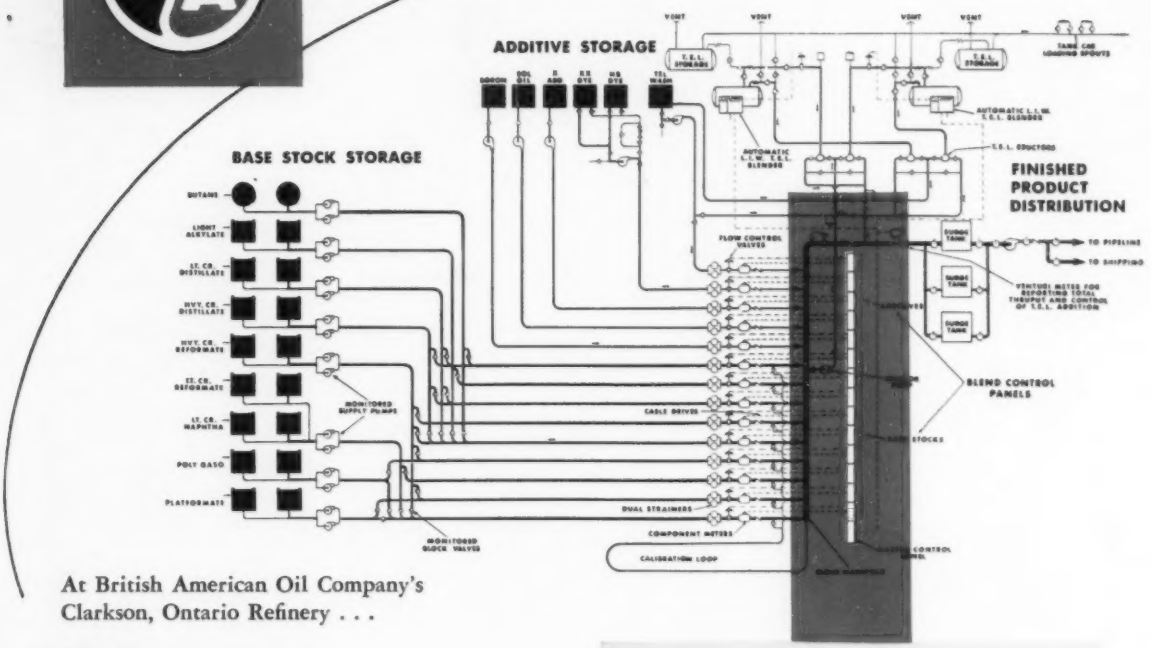
COST SAVER

When to Use Prestressed Concrete 343

For a "Quick Look" at this issue, turn the page . .

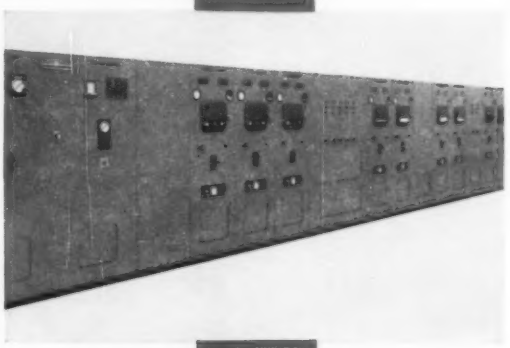
SUBSCRIPTION PRICE $2 PER YEAR
PRICE OF THIS ISSUE $1

POSITIVE CONTROL OF MATERIALS IN MOTION



At British American Oil Company's Clarkson, Ontario Refinery . . .

Tailor-made hydrocarbon blends at the twist of a dial!



As market demands change, so too do the number and nature of base stocks, dyes, additives, and TEL involved in gasoline production. British American meets these demands with the greater operational flexibility found in a Proportioneers Continuous Automatic Blending System. This system provides twist-of-a-dial, tailor-made products . . . minimizes intermediate tankage . . . and offers many design and economic features keyed to the production tempo of today . . . *and tomorrow!*

Proportioneers equipment *continuously* proportions and mixes the components . . . in proper ratio to each other and end-product demands . . . and provides safeguards to compensate for any upset. Blender operation, based on the *closed control loop,* constantly meters each stream, compares this signal with an established condition, and automatically makes any flow rate adjustments required.

Keep pace with progress by requesting complete data on this system. Write **Proportioneers, Inc., 412 Harris Avenue, Providence 1, Rhode Island.**

PROPORTIONEERS
DIVISION OF
B-I-F INDUSTRIES
METERS
FEEDERS
CONTROLS

Volume 37, No. 9 September, 1958

PROCESS HANDBOOK

Foreword 209
Index to Process Groups 211
Index to Contributors 213
Reforming Processes 215
Cracking Processes 231
Alkylation Processes 251
Isomerization Processes 251
Polymerization Processes 252
Solvent Refining Processes 271
Treating Processes 271
Other Refining Processes 271

OTHER TECHNICAL FEATURES

Alkylation—What You Should Know 316
R. E. Payne
Find Viscosity Index by Nomograph 330
D. S. Davis
From Flow Sheet to Cost Estimate 331
W. E. Hand
Data Processing Systems Cut PM Costs 335
Jack Weinberger
Suggested Practices for Unit Layout 339
J. V. Marancik
Why Prestressed Concrete Cuts Costs 343
John Makaretz
Nomogram for Tower Packing Height 346
Liang-tseng Fan
They Use Automatic Gasoline Blending 347
H. D. Applequist and James E. Krebs
Take a Look at Hexamethylene Tetramine 351
Peter W. Sherwood
Taking Stock 354

As Management Sees It...

The Fine Art of Growing Larger 391
Ernest Hart
Use Your Intuition and Imagination (How to Invent: Part II) 396
Forrest E. Gilmore
As a Supervisor—How Good Are You? 402
Robley D. Stevens

DEPARTMENTS

LOOK BOX. Featuring... Front and Center for Oil's Old Timer 201

Quick Look at Industry ... 9
Mail Box 206
Valuable Reading Ahead ... 356
Reviewing New Books ... 358
How To Do It 362
Who's Building 373
If Oil Could Speak 411
What's Happening 414
Meetings Calendar 441
Men in Industry 442
Suppliers Notes 462
Classified Advertising ... 485
New Equipment 486
Manufacturers Literature ... 486
Index to Advertisers 514
Readers Service Card ... 517

PETROLEUM REFINER, published by Gulf Publishing Company on the 12th of each month, entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879.

Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

©Gulf Publishing Company, 1958

A Quick Look

at This Issue

These handy digests permit checking ☑ the articles you want to read first.

PROCESS HANDBOOK

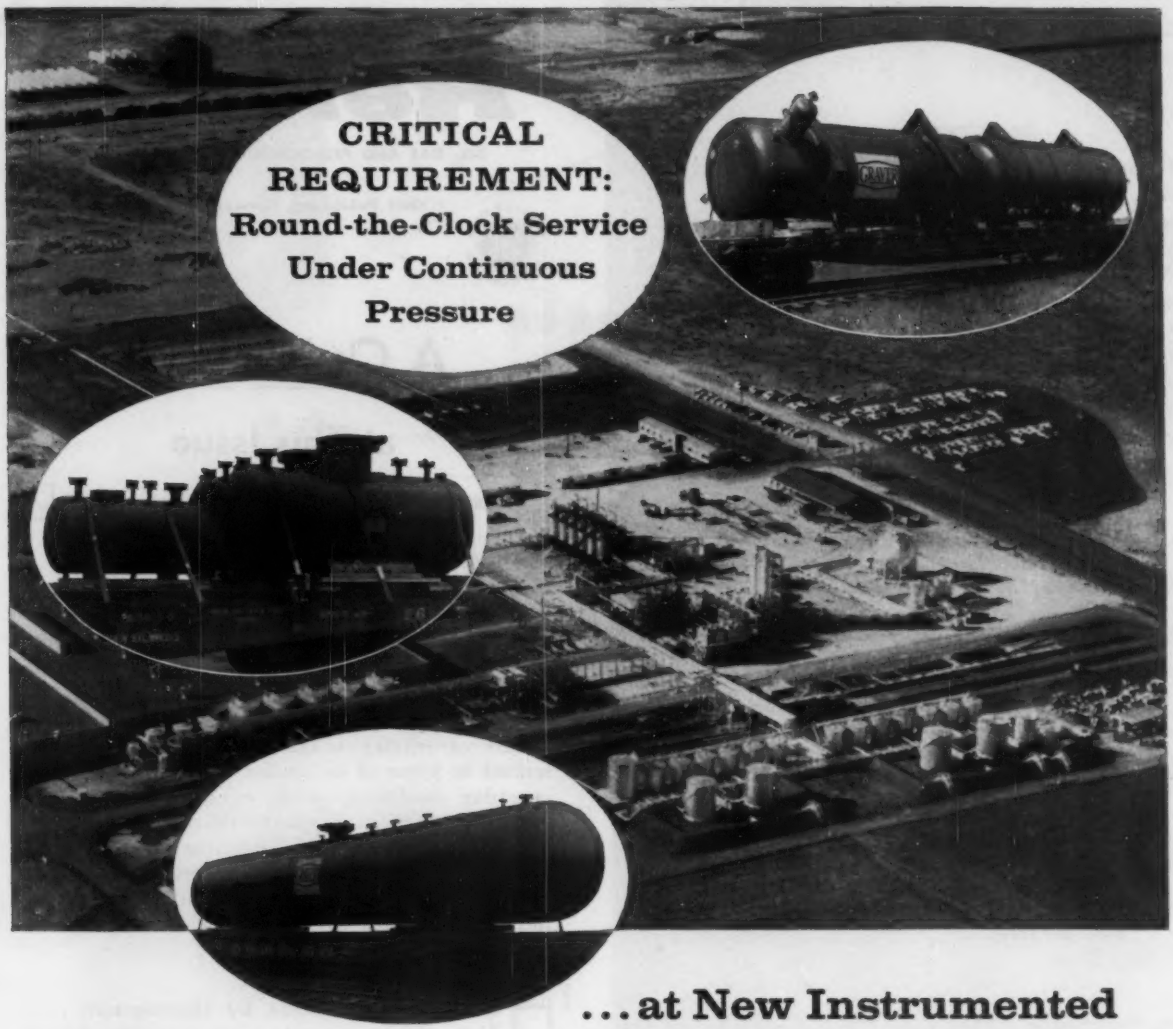
☐ **1958 Edition . . .** Here is an authoritative compilation of the most important refining processes in use today. You'll want to keep it in your reference file because it is a complete and up-to-date picture of refining technology. Each process is described in terms of its application, charge, products, operating conditions, yields, economies, and commercial installations. Literature references are given to help you get more detailed information, if necessary. All of the important processes are here—compiled and summarized under individual catagories. Start a tour through modern petroleum refining on **Page 207.**

☐ **Find Viscosity Index by Nomograph . . .** Using this nomograph and knowing the Saybolt viscosity of an oil at two different temperatures, the viscosity index can be quickly and conveniently determined. See how this nomograph can save you time and effort, turn to **Page 330.**

☐ **From Flow Sheet to Cost Estimate . . .** This short-cut "factor" method of estimating capital costs is useful for process evaluation estimates. Fast, cheap and accurate enough for this type of preliminary estimate, the method is easily adapted to your own standards and specifications. For a quick answer to pressing problems, turn to **Page 331.**

☐ **Data Processing Systems Cut PM Costs . . .** Your preventive maintenance program can be systematized and updated by using data processing machines. The result is better scheduling, increased efficiency, spare part reduction and improved labor requirement predictions. For complete details, turn to **Page 335.**

Please Turn Page ➡



...at New Instrumented GENERAL TIRE Synthetic Rubber Plant at Odessa

The nation's first privately financed and first completely integrated synthetic rubber operation owned jointly by The General Tire & Rubber Company and The El Paso Natural Gas Company at Odessa, Texas utilizes 880 instruments for absolute and continuous control by a single operator.

Just 22 months after the agreement was signed between The General Tire & Rubber Company and The El Paso Natural Gas Company, two new plants costing $32,000,000 went on stream at Odessa, Texas to manufacture GR-S synthetic rubber. Now in full production day and night, a continuous stream of raw materials enters the General Tire plant at one end, leaving the other end as bales of synthetic rubber. The entire manufacturing process demands the utmost care in the control of timing, temperatures, pressures and the proportionate quantities of the various ingredients.

Eighteen pressure vessels fabricated by Graver of ASTM A-285 Grade C flange quality steel are important links in the modern automation chain at the General Tire plant. Built to be in operation around-the-clock under continuous pressure, the 18 pressure vessels are symbolic of the meticulous fabricating craftsmanship Graver applies to processing equipment for the petrochemical, chemical and petroleum industries. Over a century of experience qualifies Graver to tackle the most exacting specifications.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA • New York • Philadelphia
Edge Moor, Delaware • Pittsburgh • Atlanta • Detroit • Chicago
Tulsa • Sand Springs, Oklahoma • Houston • New Orleans
Los Angeles • Fontana, California • San Francisco

For more data on advertised products, use Readers' Service Cards, last page.

A Quick Look at This Issue . . .

☐ **Suggested Practices For Unit Layout . . .** Esso's studies show that mobile equipment should be used to the maximum possible extent. Thus its unit design practices recommend a layout for this equipment. The result is lower unit maintenance costs. For complete details, turn to **Page 339.**

☐ **Why Prestressed Concrete Cuts Costs . . .** By introducing artificial stresses in the concrete by means of tensioned reinforcing steel, you can save on materials and have slender, pleasing structures. This article shows where prestressed concrete can have practical and economical applications in the construction of refineries and petrochemical plants. For complete details, turn to **Page 343.**

☐ **They Use Automatic Gasoline Blending . . .** Sohio has started making its fuels with a continuous in-line blending system. Now finished product storage is not required to assure a continuous flow of on-spec products. **Page 347.**

☐ **Hexamethylene Tetramine . . .** This versatile chemical accounted for almost nine percent of the formaldehyde and over 12 million pounds of the ammonia produced last year. Here's an outlet for these two basic petrochemicals that will bear investigation. You'll find a complete discussion on consumption patterns, manufacturing methods and reaction conditions by turning to **Page 351.**

☐ **The Fine Art of Growing Larger . . .** There is no doubt that expansion by acquisition and merger is a broad and fast road to industrial glory—but it should be traveled only by the strong who are blessed with plenty of fortitude. Here is a frank and honest run-down of what really happens when two companies merge or when one acquires another. For the full story turn to **Page 391.**

☐ **Use Your Intuition and Imagination . . . How To Invent (Part II) . . .** Here is the second article in this series which will teach you the mental techniques and process of learning to invent. This article discusses the conscious and subsonscious portions of your brain, and how you can most effectively use each. Also, those sudden flashes of illumination which so clearly show the answer to a problem under consideration. Turn to **Page 396.**

☐ **As A Supervisor—How Good Are You? . . .** Your success as a supervisor is reflected in the attitude, level of instruction, and performance of your workers. If your team is functioning smoothly with everyone pulling for the same goal then you've earned the right to pat yourself on the back. If this is not the case, then you had better retrace your steps to find out what went wrong. Be sure you turn to **Page 402.**

Have You Cast Your Ballot?

Next year, 1959, our great oil industry is 100 years old. And to commemorate this occasion, PETROLEUM REFINER will dedicate a major section of its January, 1959, issue to the remarkable development made by petroleum refiners in the 100 years since the Drake discovery well.

Among the special features of the Oil Centennial Issue will be a "Hall of Fame" comprising 15 or 20 individuals who have contributed most to the Oil, Gas and Petrochemical processing industry. The editors of PETROLEUM REFINER alone will not select those who should be included. Instead, we are calling on a committee of more than 22,000 persons—the readers of PETROLEUM REFINER.

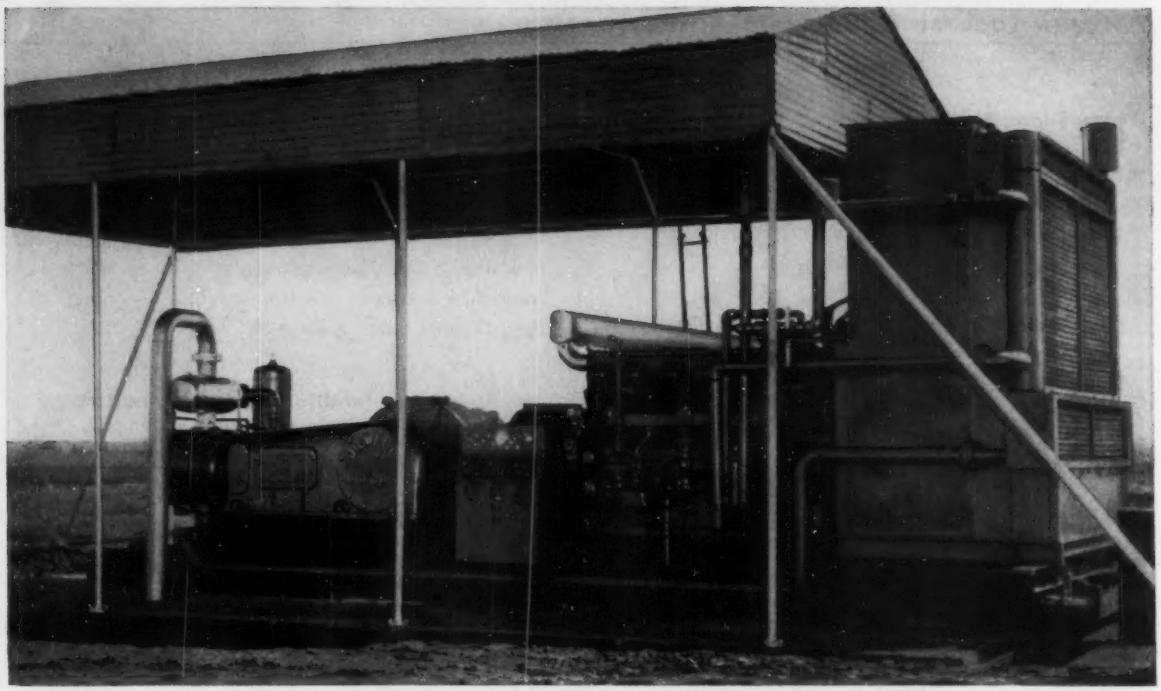
***You* are a member of this committee and we would like for you to submit the name of the one man you think has contributed the most to our great processing industry. Granted, it may be difficult to select just one individual, but we would like for you to do some serious thinking and come up with a choice.**

***Then simply write his name* on the special postage-paid postcard on the green page just inside the back cover and drop it in the mail.**

We're not setting up special eligibility rules—if you think a man should be nominated, then we do too. When we've heard from those readers who with pride would like to honor the men who have had the big roles in our industry's growth, we are sure to have a list of nominations truly worthy and representative.

From this list, the final choice can be made for the January "Hall of Fame" presentation.

THE EDITORS



This "Oilwell" DGE 300 Compressor is a two-stage unit in a gas-lift operation, and can handle up to 3,160,000 cu. ft. of gas per day at 400 psig intake and 1,500 psig discharge pressures.

Pumping gas?

See the advantages you get with

"Oilwell" DGE Compressors

In this popular DGE line, dual compressor units are mounted side by side and powered by a single prime mover through direct-connected, right-angle spiral gearing. Updraft radiator, with separate compartments for cooling engine, compressor cylinders and interstage gas . . . together with control panel and all inter-unit piping . . . are all compactly mounted on a heavy-duty, structural steel skid base. Consequently, these units are completely portable and ready for service as soon as they are installed.

Compressors are slow-speed, horizontal type—top-suction and bottom-discharge. Slow speed operation results in minimum wear on moving parts and corresponding low maintenance costs. All vital parts are enclosed.

DGE Units are available in 125 hp up to 300 hp sizes . . . and can be furnished for single or multistage compression. They have proven their superiority for many well-known companies in . . . gas-gathering operations . . . gas transmission to main distribution systems . . . pressure maintenance programs . . . recycling of natural gas . . . oil production using gas-lift . . . underground gas storage . . . and gasoline plant, refinery and petrochemical plant operations.

That's why we urge you to contact your nearest "Oilwell" store, or write COMPRESSOR DEPARTMENT, Oil Well Supply, Dallas 21, Texas . . . and get specific information on a DGE unit for every gas-pumping problem within this size range.

USS and "Oilwell" are registered trademarks

Oil Well Supply
Division of USS United States Steel

Branches Serving All Oil Fields **Executive Offices**—Dallas, Texas **Area Offices**—Calgary, Alberta · Casper, Wyoming · Columbus, O. Dallas, Texas · Houston, Texas · Tulsa, Okla. · Los Angeles, Calif. **Export Office**—30 Rockefeller Plaza, New York 20, N. Y.

Petroleum Refiner

RAY L. DUDLEY, Founder, 1891-1957

WILLIAM G. DUDLEY.....Publisher
TOM W. NELSON.....General Manager
R. M. DE SOMBRE.....Assistant General Manager
SILAS B. RAGSDALE.....Editorial Director
DR. JOHN J. MCKETTA, JR.....Chairman of Editorial Committee
GEORGE B. GIBBS.....Editor
FRANK L. EVANS, JR.....Maintenance and Design Editor
HAROLD L. HOFFMAN.....Process and Construction Editor
THOMAS C. PONDER.....Petrochemicals Editor
CLAYTON A. UMBACH, JR.....Management and Personnel Editor
HARRISON T. BRUNDAGE.....Eastern Editor
GILBERT M. WILSON.....Western Editor
DR. LEWIS F. HATCH.....Contributing Editor
WALLACE FITZGERALD.....Managing Editor
JACK COCKERHAM.....Presentation Editor
CHARLES VERVALIN.....Editorial Assistant
KATHERYNE BAST.....Editorial Assistant
EUNICE OKONESKI.....Librarian

ADVERTISING

Gene Hart, Advertising Sales Manager, Box 2608, Houston. *Representatives:* HOUSTON 19: Jack Walker, 3301 Buffalo Drive, Phone JA 9-4301; NEW YORK 17: George Skelton, Al Lucadamo, 250 Park Ave., Phone YU 6-6558; CLEVELAND 16: Harvey Dunn, Bill Westfall, 20800 Center Ridge Rd., Phone EDison 3-1650; CHICAGO 4: Martin Halloran, H. G. Fitzpatrick, 332 S. Michigan Ave., Phone Wabash 2-9330; LOS ANGELES: Jay Curts, Jim Merrill, W. W. Wilson Bldg., Huntington Park, Phone LUdlow 7-1219; TULSA 3: Jim Isaacks, 916 Enterprise Bldg., Phone CH 2-9211; DALLAS 2: Ed Thompson, 1808 Sylvan Drive, Phone RIverside 7-7344; EUROPEAN: Theodor Miocha, Agent, Limmerstrasse 31, Hannover, Germany, Phone 4-2935; UNITED KINGDOM: Frank Chambers, Agent, 120 Moorgate, London E.C.2, Phone Monarch 5661. Advertising rates on application. Cable Address: GULFPUBCO, Houston.

SUBSCRIPTIONS

F. G. Spindle, Subscription Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues) for domestic and foreign. This issue $1. Double price for copies over one year old. Subscription rates—both foreign and domestic $2 a year. Subscriptions restricted to those engaged in oil, gas and petrochemical processing industries or service and supply company personnel connected thereto. Copyright 1958 by Gulf Publishing Company.

Postmaster: Send notification (Form 3579) regarding undeliverable magazines to Petroleum Refiner, Box 2608, Houston 1, Texas.

Specialized Oil Publications of
GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

PETROLEUM REFINER and The **REFINERY CATALOG** for the oil, gas and petrochemical processing industry.

WORLD OIL (formerly The Oil Weekly) and The **COMPOSITE CATALOG** for the drilling-producing industry.

PIPE LINE INDUSTRY and The **PIPE LINE COMPOSITE CATALOG** for the oil and gas pipe line industry.

Petroleum Refiner is Indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

More Than Editorial

WE ARE ALL THE TIME bragging on our editors and our editorial content; maybe this switch will be somewhat refreshing.

As we seek to check address stencils of new PR subscribers we ask them for a list of articles which they have found of particular interest and value. One such subscriber, replying from Cleveland, Ohio, recently said it this way:

"The Look Box and What's New in Equipment are always read without fail by our engineers."

And then he added (and this is what we had in mind expressly when we conceived this item) an opinion that ought to make advertising copy writers and agency account men grin:

"The quality and contents of the advertisements that appear in your magazine are outstanding."

This pleases us too because we've contended all along that any PR reader who passes up the ad pages is missing a great deal "of interest and value."

Two Thanks to an "Ap"

WE WERE MADE HAPPY a few weeks ago to get a letter from James P. ApRoberts, a Californian who reads PR. Pleased because of two things:

1) Mr. ApRoberts had something nice to say about our favorite processing magazine, declaring that he was using "as supplemental reference for my students the excellent articles on piping costs" which PR published in March. Mr. ApRoberts teaches a course in Advanced Construction Costs at the UCLA Extension Division. And then,

2) This poor beknighted editor had never known before that the prefix "Ap" was used by certain families as a part of their surnames. Like "Mac" it denotes "son of."

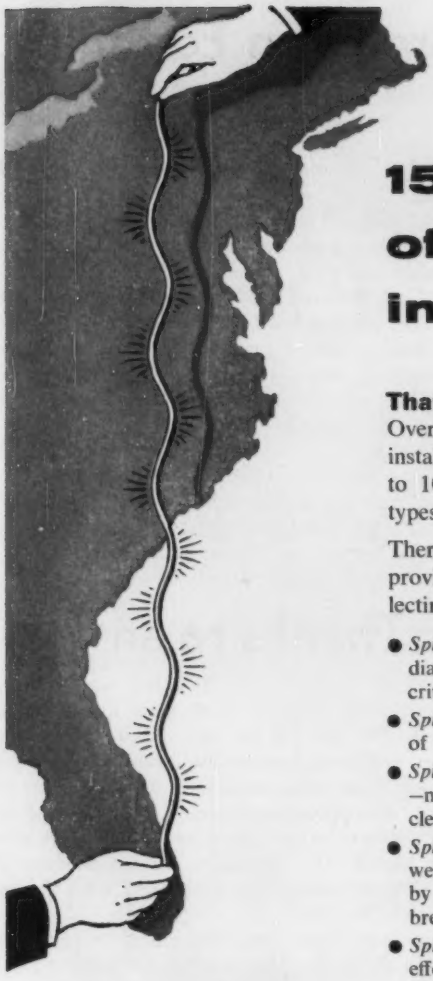
So double thanks, Mr. ApRoberts!

Suggestion for the Card Filer

SOME READERS like to file abstracts of articles on 3x5 cards. It's a good system if you keep it up. To make it easier for you, maybe you've noticed that our "Quick Look at the Issue" pages are now separated by an ad. This enables the filer to clip out each abstract (we call 'em squibs) and paste them on cards. And even if you don't use a card system, you'll find the squibs on Pages 3 and 5 a big time saver in deciding what to read first.

A Timely "How" for All Readers

SOME READERS have asked what they can do about fixing up pages from PETROLEUM REFINER for their notebooks now that the technical pages are being perforated for easy removal. No better place of telling you how to do it, we said to each other, than in our own How To Do It department; so if you'll turn to Page 371 you will find described a method that our own editors have used with success.

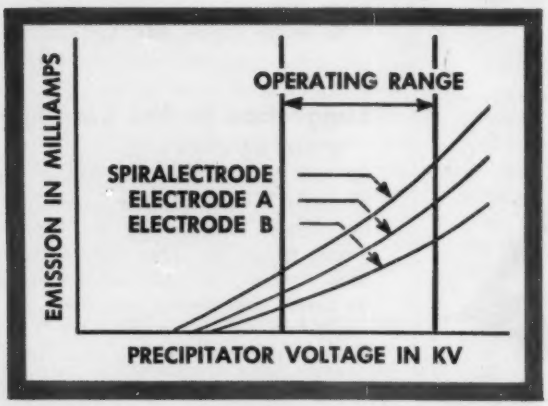


1500 miles of Spiralectrodes in Precipitator Service!

That's real proof of superior performance. Over 1500 miles of these emitting electrodes have been installed in 'SF' electric precipitators . . . delivering 50 to 100% more electron emission than conventional types of electrodes.

There are sound reasons why Buell *Spiralectrodes* are providing superior emitting efficiency in actual dust collecting applications.

- *Spiralectrodes* are *"emission engineered"* – pitch and diameter are custom designed for each application . . . of critical importance with high resistivity dust.
- *Spiralectrodes are precision made from stainless steel*– of uniform quality, corrosion-resistant.
- *Spiralectrodes minimize efficiency-loss of dust build-up* –no horizontal surface to collect dust, positive rapping cleans electrodes.
- *Spiralectrodes maintain predetermined tension* – (no weights required) . . . dampen effect of vibration caused by electrical pulsation, thereby minimizing electrode breakage.
- *Spiralectrodes'* controlled area emission stops sparking effect of "point emission."



Above chart illustrates the superior emission of the Spiralectrode: its corona voltage is lower and its emission is higher than other types of emitting electrodes over the entire operating range of industrial precipitator voltage.

The superior operating characteristics of Spiralectrodes contribute to continued high efficiency of Buell 'SF' Precipitators. Detailed information of this and other exclusive features are described in a booklet, "Buell 'SF' Electric Precipitators." Send for your copy: write Dept. 21-I, Buell Engineering Company, Inc., 123 William Street, New York 38, New York.

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

For more data on advertised products, use Readers' Service Cards, last page.

A Quick Look at the Industry THIS MONTH

A Trade Bill, But No Import Plan . . . Congress finally agreed on four-year extension of Reciprocal Trade Bill—without mandatory oil control measures producers tried so desperately to tack on. Bill did include though, clause outlining additional yardsticks for determining if imports are hurting U. S. industry or national security. Clause also says if President sees necessity to restrict imports of some commodity, he must also restrict derivatives of commodity.

Independent Petroleum Assn. of America viewing this, claims defense authorizes and directs President "to take the necessary action to reduce all petroleum imports, crude and product alike,"—but don't expect Administration to agree!

National Coal Assn. also entered the ring by vowing swift action "to seek restrictions on residual oil imports which have cut heavily into coal's traditional markets on Atlantic seaboard," again—don't look for quick move by Ike!

According to late reports, however, new and different import plan is being molded in Washington. It's not certain, but presumably plan will be based on domestic demand and refinery runs. Hypothetical example: if domestic demand is 10 million bpd and imports make up 10 percent of this, import quota would be one million bpd. This pie would be sliced according to domestic thruput; i.e., if company accounts for 20 percent of domestic thruput, it would be entitled to 20 percent of import quota—200,000 barrels daily in this example.

Oil Work Getting Safer . . . Injury frequency rate in oil and gas industry was lower in '57 than any year since statistics were first collected in 1942 by BuMines. Injury rate of 9.32 per million man-hours in '56 was reduced to 8.93 last year. Refiners recorded 22 fatalities—down 4 from '56.

Synthetic Producers Must Toe Price Line . . . Synthetic rubber producers are fast realizing they will be able to stay in competition with natural rubber only by holding present prices. With natural gradually sliding below price of synthetic and seeming to stabilize at lowest price in years, competition is really rough. Recent survey among synthetic producers, however, indicates they want to raise prices—if this happens it's a sure bet consumers will lean even further to natural.

"Unconcern" Threatens Depletion Status . . . Both sides of battle over percentage depletion agree on one thing: oil and gas industry has weakened position because it failed to counteract bad publicity and ignored change in taxpayers' attitude. In recent Senate vote to slash present allowance, anti-depletion forces mustered more than three times the strength of similar battle in 1951. Vote surprised industry and encouraged anti-depletion group which is already looking for another try in near future.

Commercial Jets Boost Kerosine Needs . . . According to recent report, there will be 254 pure jets and 131 turboprop planes in commercial use by 1961. New jets will use three times as much fuel to fly same distance as present DC-7C's and, of course, fuel will be either kerosine or JP-4. Example: Boeing 707 is reported to consume about 20,000 gallons per hour. Accent must be on "clean" fuel, free from foreign matter such as water, rust or dirt of five microns or larger in diameter.

One portion of industry may take setback, however. Airlines spokesman says future airport ramp installations must be made of rigid-type material (concrete) which

will not deteriorate when subject to fuel spillage. Slow evaporating kerosine-type fuels eat away at flexible-type surfacing—this no doubt means asphalt.

Petrochemicals Do It Again . . . For those who get a back pain from just thinking about waxing the car, petrochemicals have come to the rescue. New paint for '59 Chrysler-builts will use epoxy resin primer and higher melamine content finish coats. Combination promises to keep new-car look up to three years.

Yield Ratio May Cause Pains . . . Sinclair board chairman P. C. Spencer fears industry will wind up with heating oil shortage in fourth quarter and another burdensome gasoline excess at year's end if it maintains current refinery yields of about 53 percent gasoline and 25 percent distillates.

Present Octanes Best for Motorist . . . Recent Cal Research studies indicate most economical gasoline octane number with present processing methods is around 97 for average drivers—providing compression ratio is adjusted to gasoline. Thus, with present octanes, point of maximum economy to motorist has already been reached or passed.

Economics are based upon present commercial practices regarding improved efficiencies of higher compression ratio cars and soaring costs of higher octanes. Both can change and probably will.

Chemical Hybrids For High Energy . . . High energy fuels of space age will probably come from fast growing group of chemicals called organometallics. Organometallic is a chemical hybrid composed primarily of carbon, hydrogen and metal. Until recently, best known was tetraethyllead. Now, through manufacture of organometallics, whole new branch of chemical industry is developing.

What's The Octane Picture? . . . Still steady as a rock with octanes unchanged for the sixth straight month Premium remains at 98.5 while regular clings to 91.2. Who said anything about another octane race?

Nuclear Use In Oil . . . At Geneva conference on peaceful use of atomic energy, Esso reported economics still not clear. What's needed now is more research to decide which processes can use radiation competitively with conventional methods.

Findings to date:

Cobalt-60 provides radiation in small processing units at commercially attractive cost.

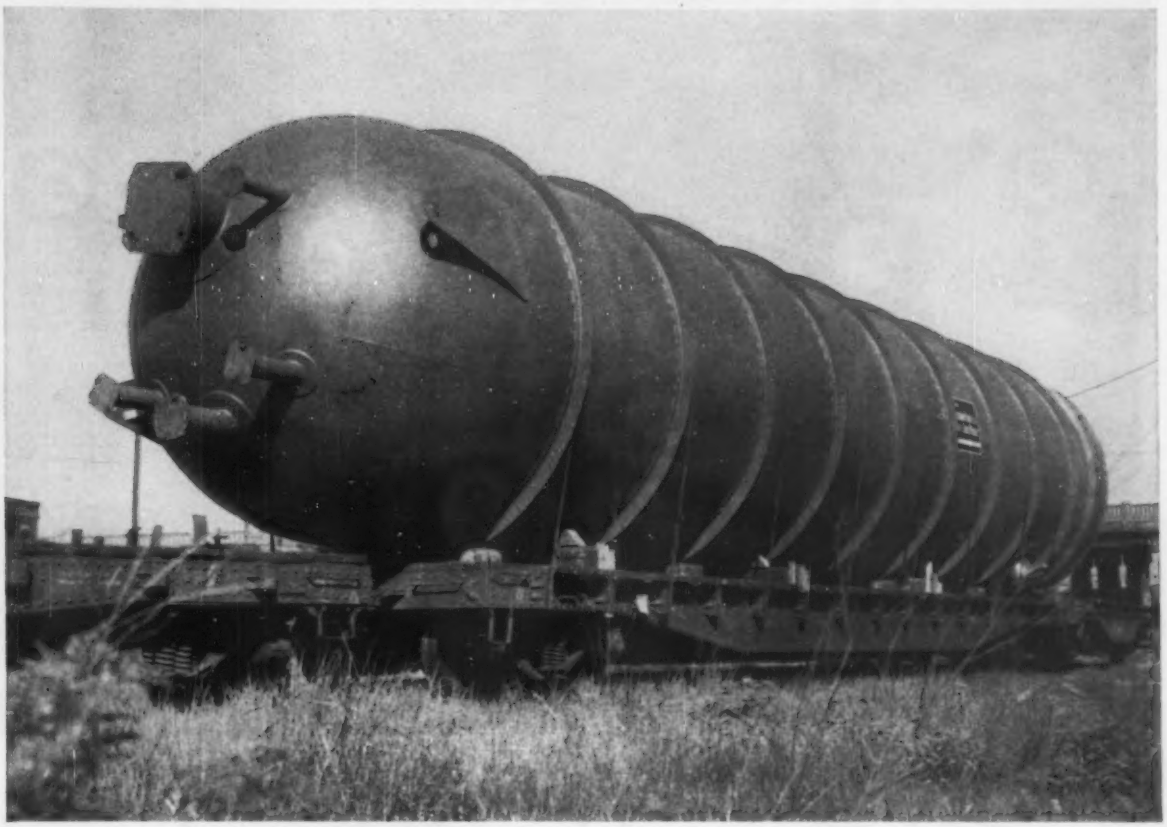
Specially designed nuclear reactor offers cheapest radiation but operates economically only in large capacities.

Electron accelerators—commercial adaptions of atom smashers—will do job cheaper than cobalt-60 in intermediate sizes.

Quick Look Around the World . . . Natural gas continues to hold edge over fuel oil and coal in supplying electric power plants . . . British Petroleum forms new company, BP Overseas Refining, to hold parent's interest in future overseas refineries . . . Superior Oil abandons trademark plans of letter 'S' snaking through 'O' because of possible conflicts with Standard Oil symbol . . . Navy claims new ship propellor for small high-speed craft will "decrease substantially" fuel consumption at top speeds.

Oil Stock Losing Prestige? . . . For more than a decade, investment report contends, oil stock has offered investors splendid hedge against inflation. However, report also said crude price increase early in '57 is likely to be last advance for several years. Having lost ability to raise prices virtually at will, oil industry is no longer inflation hedge it was.

MTB Fabrication Fact Sheet



Giant Vacuum Bottle for Catalyst Storage

This vessel, recently shipped to a well-known Midwest refiner, was fabricated from ASTM A-285 Grade C steel. It measures 13′ x 70′ long and weighs 35 tons. The shell, designed for a full vacuum, is reinforced with external Tee bars, while the head is hemispherically shaped and the bottom toriconically shaped—thus reducing the over-all thickness of the vessel.

In addition to quality fabrication, on-time delivery of this job was a major consideration and Missouri Boiler kept its promise to help this contractor meet a vital construction schedule.

If you would like to solve your delivery and scheduling problems, add Missouri Boiler to your bidders' list for dependable quotations on custom fabricated pressure vessels and storage tanks.

(steel and alloy plate—3/16" to 1-1/4" stress relieved X-rayed)

MISSOURI BOILER AND TANK COMPANY

Formerly Missouri Boiler and Sheet Iron Works

2216 Papin Street **St. Louis, Missouri**

For more data on advertised products, use Readers' Service Cards, last page.

Now! Ready-to-install in a single package—

- **High-temperature insulation**
- **A protective metal jacket**
- **A built-in vapor barrier**

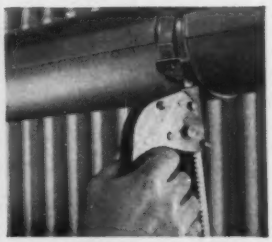
The insulation in Metal-On is Johns-Manville Thermobestos® . . . finest of all the calcium silicate insulations for service to 1200°F.

From carton to . . . with

Thermobestos calcium silicate insulation

5 SECONDS TO REMOVE Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!

15 SECONDS LATER the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.



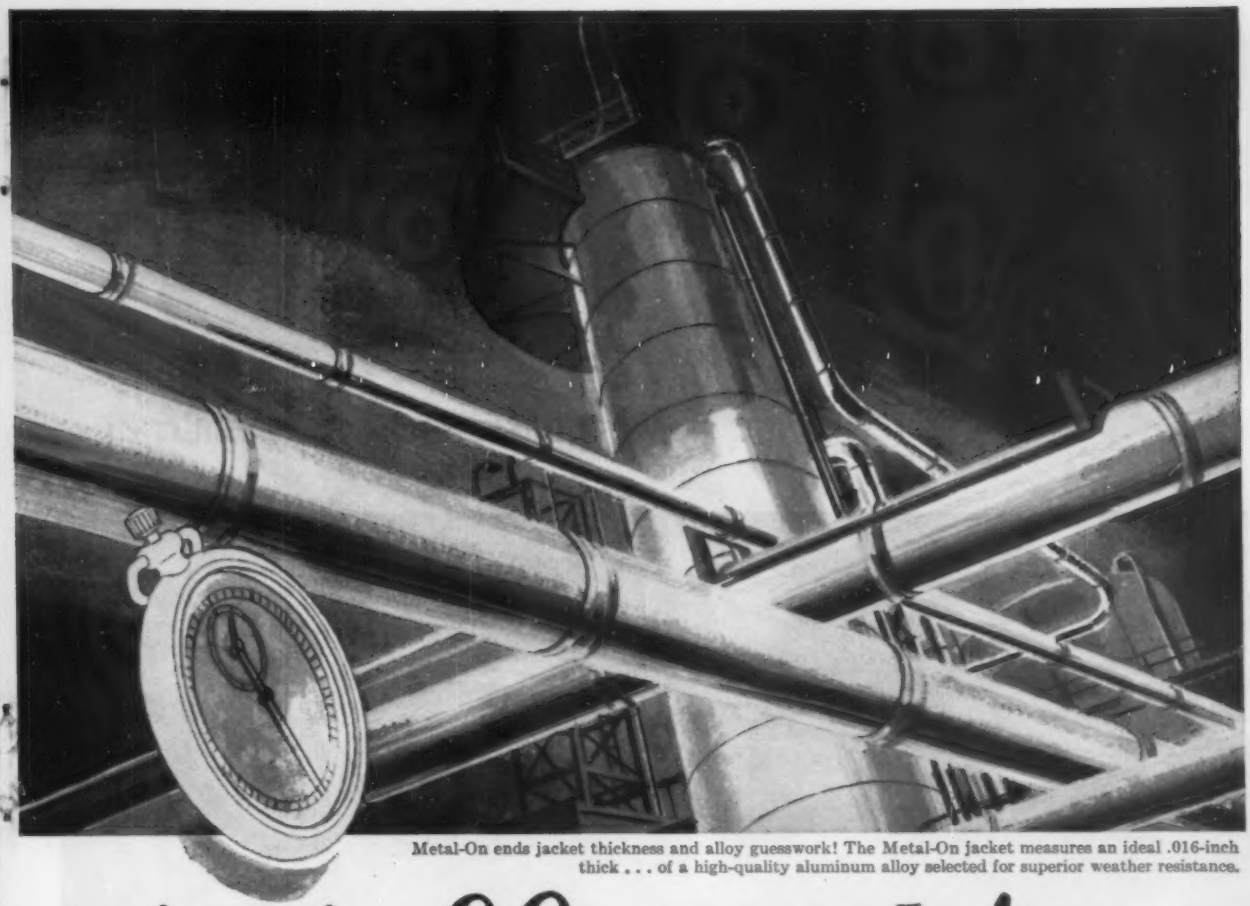
METAL BAND provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

Snaps in place . . . F-A-S-T!

J-M's new Metal-On consists of Thermobestos calcium silicate insu-



Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

pipe in 90 seconds!

new J-M METAL-ON Insulation!

factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

Right alloy . . . proper thickness

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

Metal-On presents no fitting problem. It is cut easily right on the job with either power or hack saws. Available in 36″ sections in a complete range of pipe sizes through 24″ . . . by 3″ thickness.

To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS...1858-1958

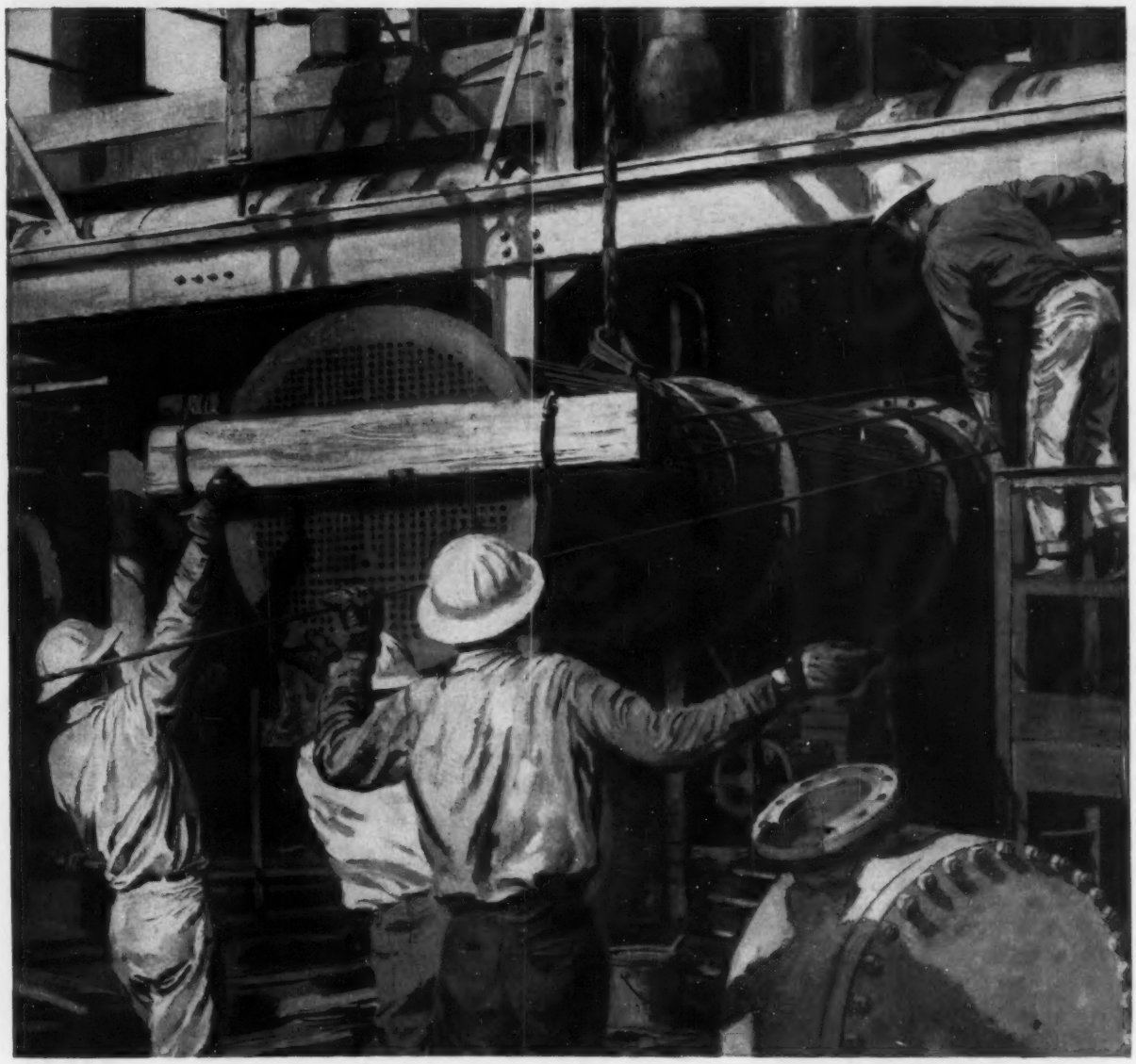
JOHNS-MANVILLE JM PRODUCTS

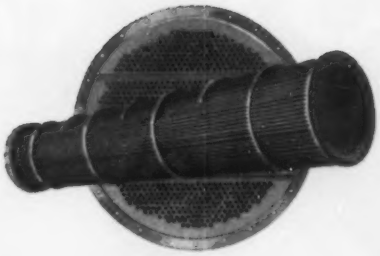
For more data on advertised products, use Readers' Service Cards, last page.

RETUBE YOUR BUNDLES WITH

PHELPS DODGE HEAT EXCHANGER AND CONDENSER TUBES

FOR LONG-RUN RELIABILITY!





- Wide range of finest quality copper-base alloys—bi-metal combinations—to fit your application needs.
- Well-stocked, nation-wide warehouses at Houston, Tulsa, Los Angeles and Bayway, N. J.
- Experienced engineering staff at your service to help solve tube corrosion problems.

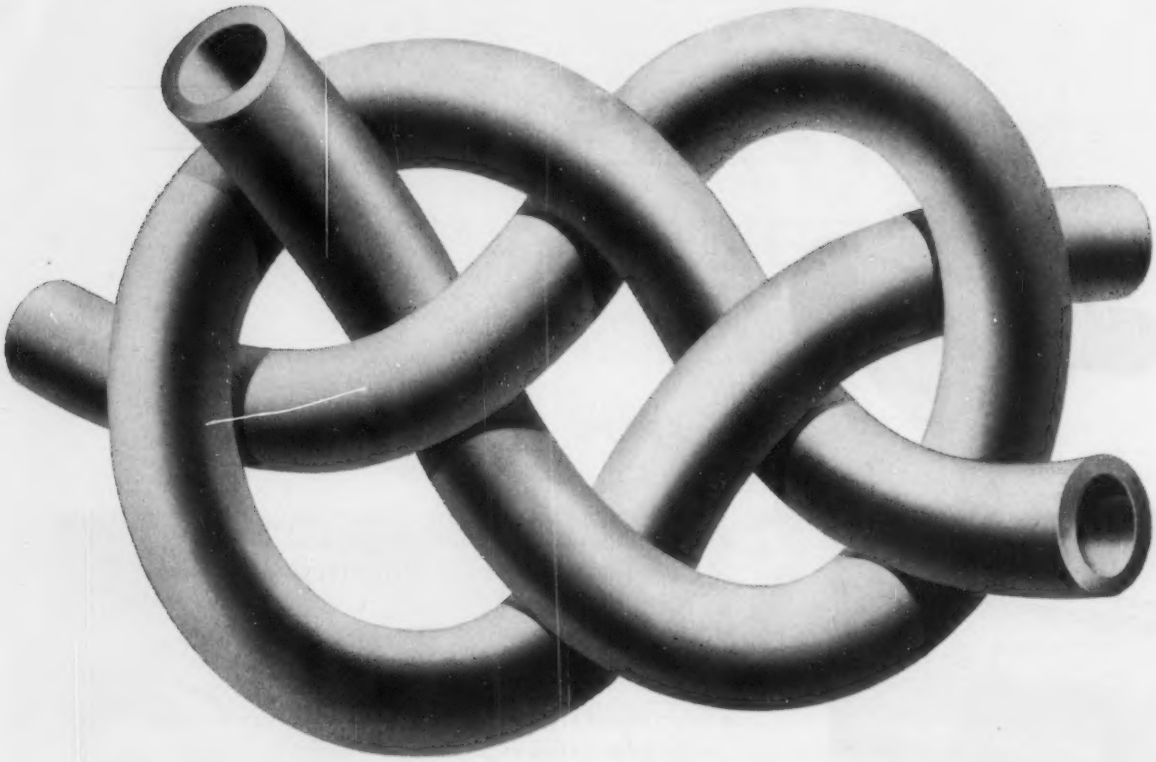
Specify Phelps Dodge . . . a leading manufacturer of tubes for the fabricators of heat exchangers and condensers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!

For more data on advertised products, use Readers' Service Cards, last page.



Knotty pressure tube problems?

Let Timken Company metallurgists select the one steel analysis that gives you maximum tube life per dollar

IF cost weren't a factor, you could choose from a number of high temperature steels to handle your pressure, temperature and corrosion problems. But to get the greatest economy means finding the *one* steel analysis that gives you the longest tube life per dollar.

That's where Timken Company metallurgists can help you. They're recognized experts in high temperature steels, with over 25 years of research and production experience. They've solved hundreds of industry's most difficult pressure tube problems. And they've done it economically.

There's no problem in getting the right steels, either. You can get Timken® seamless pressure tubes in sizes up to 11″ O.D. x 3″ wall. They're available in all stainless and alloy grades to meet almost any combination of operating conditions. Composition is exact because we make only electric furnace fine alloy steel. And through rigid quality control, the steel is uniform from heat to heat, tube to tube, order to order.

To untie your knotty pressure tube problems *and* save money, call on Timken Company metallurgists. The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

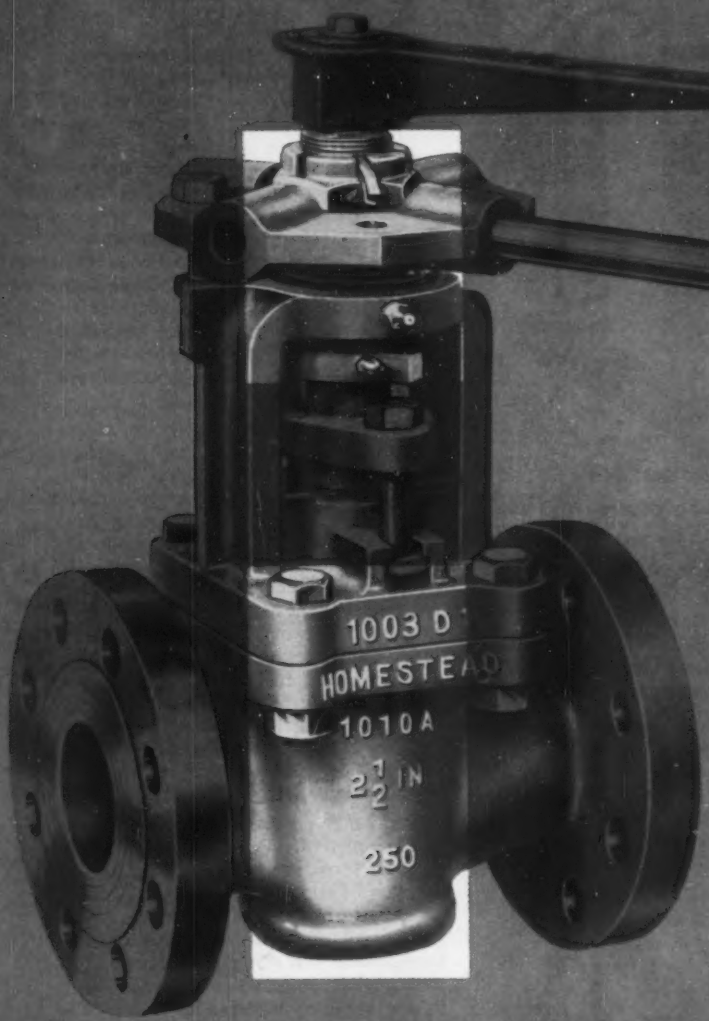
TIMKEN *Fine Alloy* **STEEL**

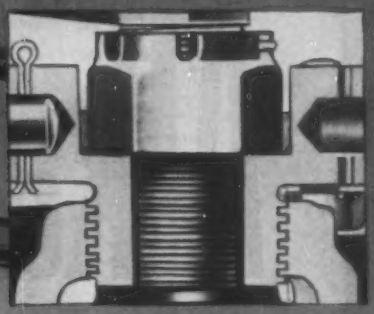
TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

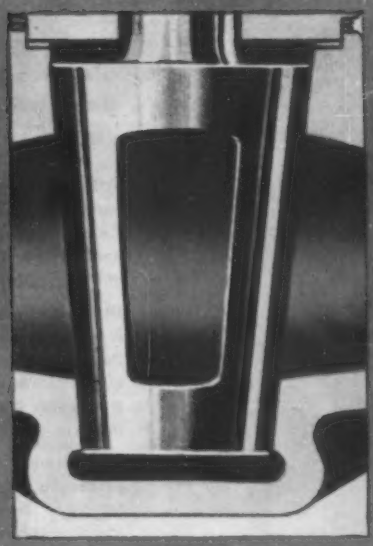
In the spots that count... Homestead® Valves are

STICK-PROOF





Built-in lever and screw affords instant operation



Seating pressure is mechanically relieved for easy turning

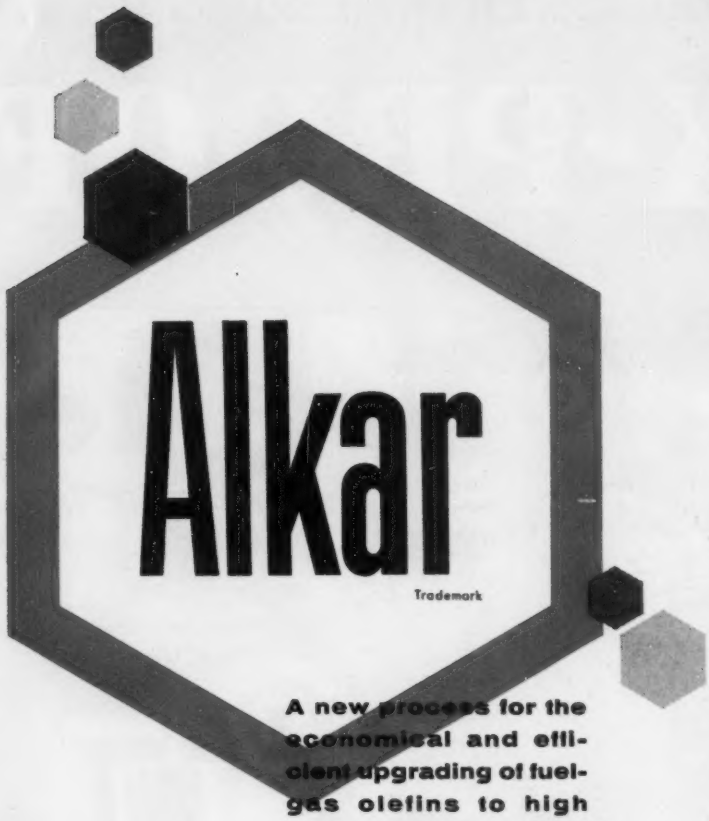
TROUBLE-FREE SERVICE is assured under all fluid, temperature and pressure conditions by the exclusive design of Homestead Lever-Seald Valves.

Instant stick-proof operation is guaranteed by a built-in lever and screw which mechanically relieves seating pressure. This controlled relief of pressure is only sufficient to overcome friction and to permit the plug to turn freely. What's more, all operating parts are protected from the damaging effects of corrosive or erosive service conditions and are completely weatherproof.

Write today for fully detailed Reference Book 39—Section 3. See for yourself how Homestead Lever-Seald Valves can solve your problems on high temperature, pressure or corrosive services.

h
v

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box 45 • Coraopolis, Pa.



A new process for the economical and efficient upgrading of fuel-gas olefins to high value alkylaromatics

Alkar, now being made available to refiners by Universal Oil Products Company, provides the first economical means for the efficient use of ethylene without costly prior separation.

Diversification of refinery products is attained by use of this process through channeling a portion of total output into the important new markets created by the growing demand for petrochemicals.

The favorable economics of Alkar processing allow application of this technique in all sizes of refineries, thus permitting entry of new operators into the petrochemical field.

Alkar is one of many UOP petrochemical and refining processes available to refiners everywhere. We will be glad to provide full information on this or any other UOP process without obligation.

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road,
Des Plaines, Illinois, U.S.A.
More Than Forty Years Of Leadership In Petroleum Refining Technology

New UOP Petrochemical and Petroleum Processes Now Available To Refiners

Two new processes, Alkar and Butamer, recently announced by Universal Oil Products Company, offer a great potential for helping refiners secure maximum profits from their operations. Alkar provides the refining industry with a practical means of enjoying the increasing market for petrochemicals with minimum capital investment and profitable operational ratios. Butamer offers the refiner an economical method of securing isobutane.

The Alkar process permits the utilization of the light olefin content of fuel gas on a much larger scale than has previously been practical for the average refiner. The recovery of this by-product olefin from off-gas streams has been frequently impractical because of the very substantial investments necessary for separation equipment. In the development of the Alkar process, UOP worked on the premise that great economies would result if the by-product olefin could be chemically converted without the necessity of prior concentration. The accomplishment of this with the Alkar process now makes it possible for many more refiners to enter the petrochemical field.

The Alkar process is based on the use of a completely new catalyst. This catalyst, in solid form, is used as a fixed bed in reactors of conventional design. The catalyst being non-corrosive, the use of expensive alloys in reactor construction is unnecessary. It is stable against conditions normally encountered in processing and in the handling required in loading the reactors. Catalyst costs are low and special catalyst handling equipment requirements are at a minimum.

Another potential application of the Alkar process provides for the upgrading of fuel gas value olefins to premium octane motor fuel. This is accomplished by the use of the Alkar process to react the olefins with aromatics produced by catalytic reforming.

The Alkar process is but one of a number of petrochemical processes UOP makes available to the refining industry. For many years UOP's research and engineering staffs have been actively developing processes

For more data on advertised products, use Readers' Service Cards, last page.

Alkar and Butamer processes increase refining profits with minimum investment

which yield valuable chemicals from petroleum raw materials and refinery by-products. To provide a broad range of processes for a refiner's every need, Universal also licenses several processes originated by others. UOP petrochemical processes available to refiners include . . . Catalytic Condensation . . . Olefin Extraction For Butylene Recovery . . . Catalytic Dehydrogenation . . . Hydrar* . . . Udex® (originated by Dow Chemical Company) . . . Two-Stage Unifining* . . . Arosorb* (originated by Sun Oil Company).

The Butamer Process

The Butamer process fills the need for an efficient and economical method for converting normal butane to isobutane. This process is particularly important at this time because of the growing demand for isobutane resulting from the increasing use of alkylate for blending into motor fuels.

This process is the result of extensive UOP research and development to secure an improved normal butane isomerization technique. The accomplishment makes it possible for refiners to have, at minimum capital investment, a practical and profitable means for normal butane isomerization.

The basis of this process is the development of a stable and rugged catalyst, capable of operating at relatively low temperatures. Low temperature operation is essential so that the concentration of isobutane in the effluent from the reactor will be sufficiently high to eliminate excessive recycle of normal butane.

Data obtained with the platinum-containing Butamer catalyst show that temperatures in the range of 600° F. to 850° F. will produce an equilibrium concentration of isobutane in the total butane effluent ranging from 49% to 40%. The process is operated under hydrogen pressure.

A low hydrogen-to-charge ratio is used. The high activity of the catalyst makes it possible to operate the process at economical liquid hourly space velocities. This makes possible a reasonable catalyst inventory.

UOP will be glad to supply, without obligation, individual recommendations for the practical application of its various petrochemical processes to any refining operation, anywhere in the free world.

*Trademark

A new non-corrosive process for the efficient and economical conversion of normal butane to iso-butane

Butamer, now being made available to refiners by Universal Oil Products Company, will help meet the increasing demand for iso-butane.

Development by UOP of a special platinum-containing catalyst permits the efficient production of iso-butane especially as feed for alkylation processes.

Minimum initial investment for Butamer installations is achieved as its flexible design permits economical integration with alkylation units.

Mild operating conditions are used in the Butamer process resulting in little loss to by-products.

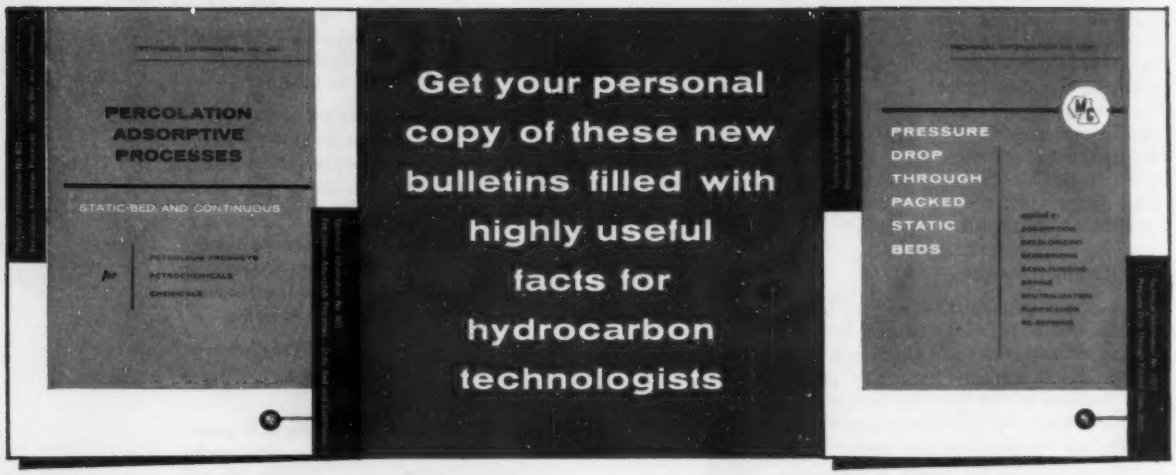
Butamer is one of many UOP petrochemical and refining processes available to refiners everywhere. We will be glad to provide full information on this or any other UOP process without obligation.

For more data on advertised products, use Readers' Service Cards, last page.

MIN CHEMISTRY *at work*

. . . which also means contributing to the literature of the industries we serve

Here's help for the idea man



Get your personal copy of these new bulletins filled with highly useful facts for hydrocarbon technologists

"Percolation Adsorptive Processes . . . Static-Bed and Continuous"

Here's an idea-stimulating, study-in-depth of the potentials of sorptive processing. Twenty-four pages in all, the factual text is supported by process flow diagrams, 14 graphs, charts and curves, and 7 compilations of important tabular data.

"Pressure Drop Through Packed Static Beds"

This bulletin leads you from typical applications through basic design equations to typical design procedure. Charts include friction factor vs Reynolds Number for flow of liquids through packed static beds, as well as calculated values of mean equivalent particle diameter.

HERE ARE TWO EASY WAYS TO GET YOUR PERSONAL COPIES OF THESE HELPFUL BULLETINS

1. Fill in and mail the coupon.
2. Use the inquiry card device next to the back cover of this publication.

For more data, see your Refinery Catalog, pages 618-619

MINERALS & CHEMICALS
CORPORATION OF AMERICA
5314 Essex Turnpike, Menlo Park, N. J.
Please send me without obligation:
☐ "Percolation Adsorptive Processes . . ."
☐ "Pressure Drop Through Packed Static Beds"
☐ Specific guidance and samples for proposed application in
_____
name_____
company_____
address_____
city_____ zone____ state_____

MINERALS & CHEMICALS
CORPORATION OF AMERICA
5314 Essex Turnpike, Menlo Park, N.J.

Leaders in creative use of non-metallic minerals
ATTAPULGITE (*Attapulgus*)
ACTIVATED BAUXITE (*Porocel*)
KAOLIN (*Edgar • ASPs*)
LIMESTONE (*Chemstone*)
SPEEDI-DRI FLOOR ABSORBENTS

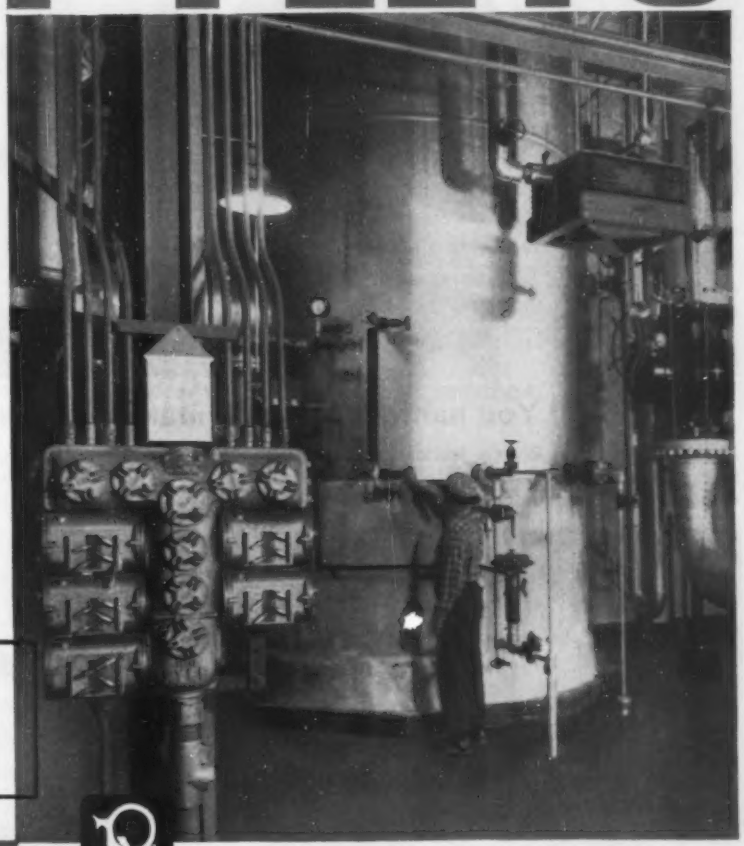
explosion-proof PYLETS®

specified for McMahon Gas Processing Plant Fort St. John British Columbia

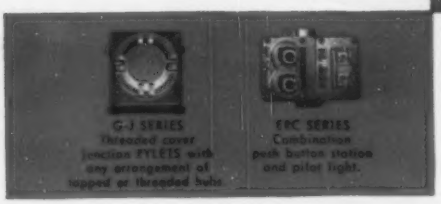
Explosion-proof PYLETS exceed code requirements and provide maximum protection for personnel and property against explosion and fire.

PYLETS are designed for quick, easy installation and convenient maintenance. Rugged construction insures a long service life.

- **Taper tapped hubs**
- **Smooth, roomy interiors**
- **Quick acting joints**
- **Dependable Mechanisms**
- **Aluminum alloy or heavy cadmium plated ferrous alloy castings**



Pyle-National panelboard, lighting fixtures, and other Pylets in Absorption & Dehydrating building, McMahon Gas Processing Plant. Stearns-Roger Engineering Co., Ltd. specified Pyle-National controls, conduit fittings and lighting fixtures throughout.


G-J SERIES
Threaded cover junction PYLETS with any arrangement of tapped or threaded hubs
ERC SERIES
Combination push button station and pilot light.

SINCE 1897

Sold Nationally Through Authorized Distributors. Write for Literature.

THE PYLE-NATIONAL COMPANY

WHERE QUALITY IS TRADITIONAL

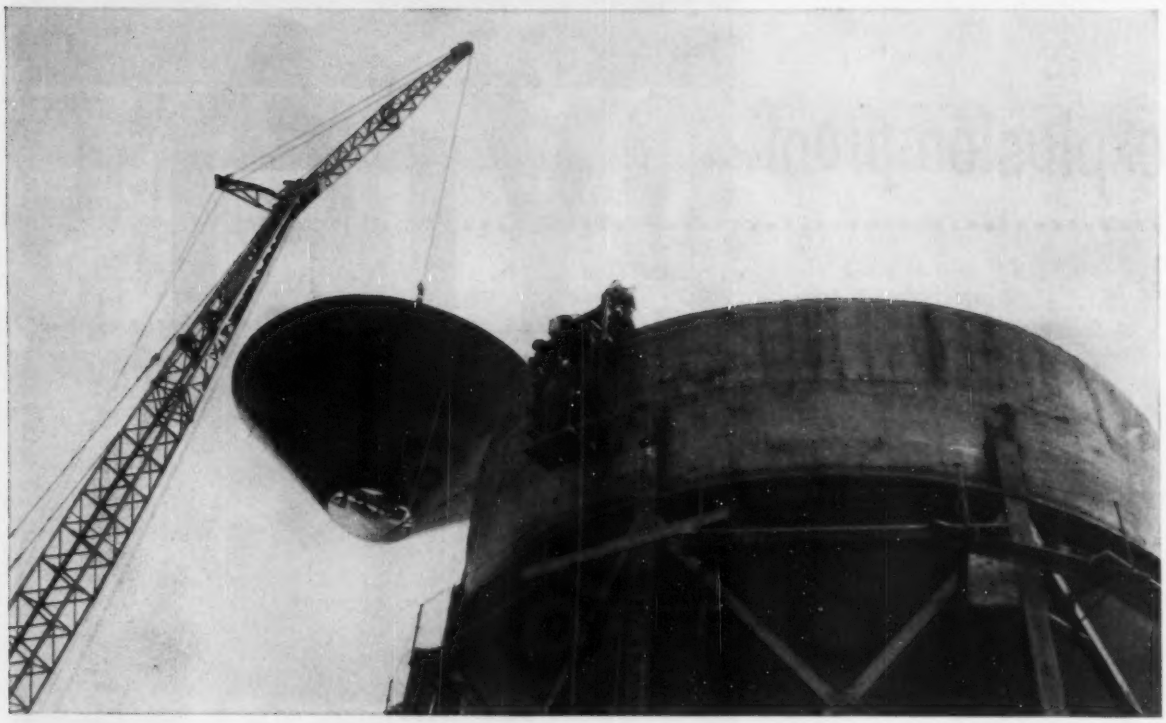
1393 North Kostner Avenue, Chicago 51, Illinois

Branch Offices and Agents in Principal Cities of the U. S. and Canada
Railroad Export Department: International Railway Supply Co., 30 Church St., New York 7, N. Y.
Industrial Export Department: Rocke International Corp., 13 E. 40th St., New York 16, N. Y.
Canadian Agent: The Holden Co., Ltd., Montreal

CONDUIT FITTINGS • MOTOR CONTROLS • CONNECTORS • FLOODLIGHTS

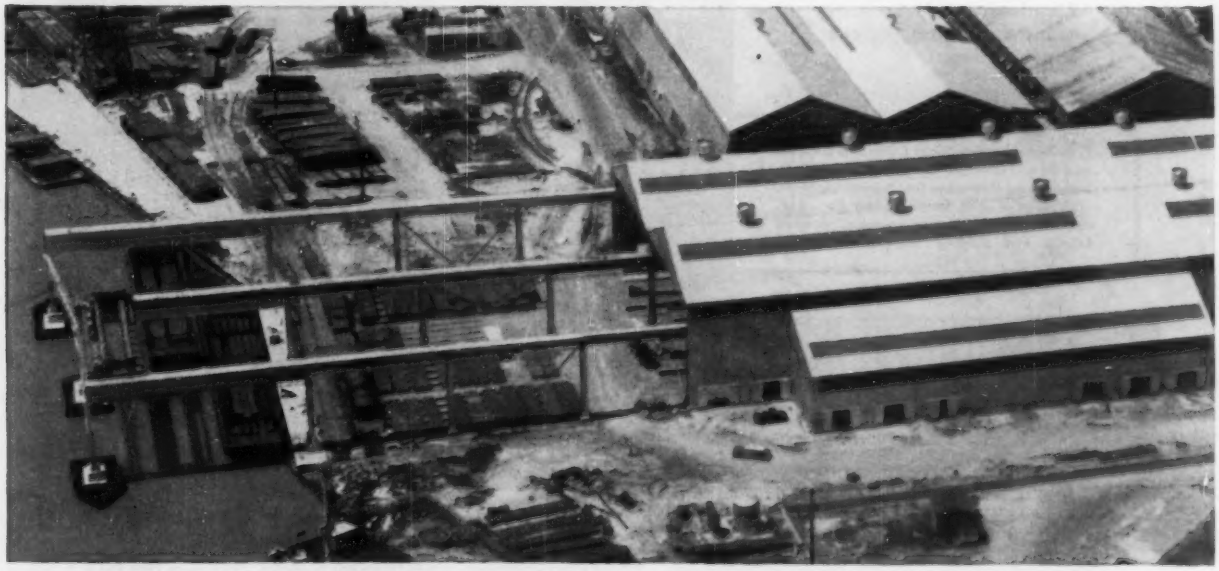
For more data on advertised products, use Readers' Service Cards, last page.

Ready now at Orange, Texas



You name it . . . we'll make it . . . and erect it too!

Anything American Bridge fabricates, it can also erect. Possessing the most complete range of construction equipment in the industry and skilled personnel backed by over 50 years of experience, we can handle any plate job anywhere. American Bridge has no peer in the specialized business of steel construction.



BIG EQUIPMENT for important jobs. The modernized plate fabricating shop is a two-aisle building, 177′ wide and 750′ long, with extended crane runways, 270′ and 200′ lengths at either end. The heavy aisle is furnished with two 50-ton, one 15-ton and one 10-ton crane and the light aisle has one 25-ton, one 15-ton and one 10-ton crane.

modern fabricating facilities for

Top-quality plate work of all kinds

Tanks • Pressure Vessels • Stacks • Bins • Pipe

To better accommodate the growing needs of the dynamic industries of the South and Southwest, our Orange, Texas, plant has been completely modernized, enabling us to handle literally any type and size of plate work—including heavy wall pressure vessels for the petroleum, chemical, paper and other industries.

Plate fabricating facilities include large car bottom-heating and stress-relieving furnaces, high-capacity bending rolls, a variety of presses and press brakes, the latest in welding and X-raying equipment, high-capacity plate shears, edge planers, boring mills and drills.

The plant, strategically situated to serve the industries of the South and Southwest promptly and economically by rail, truck or water, is also designed for fast, efficient material handling. It is equipped with 7 cranes capable of lifting over 100 tons.

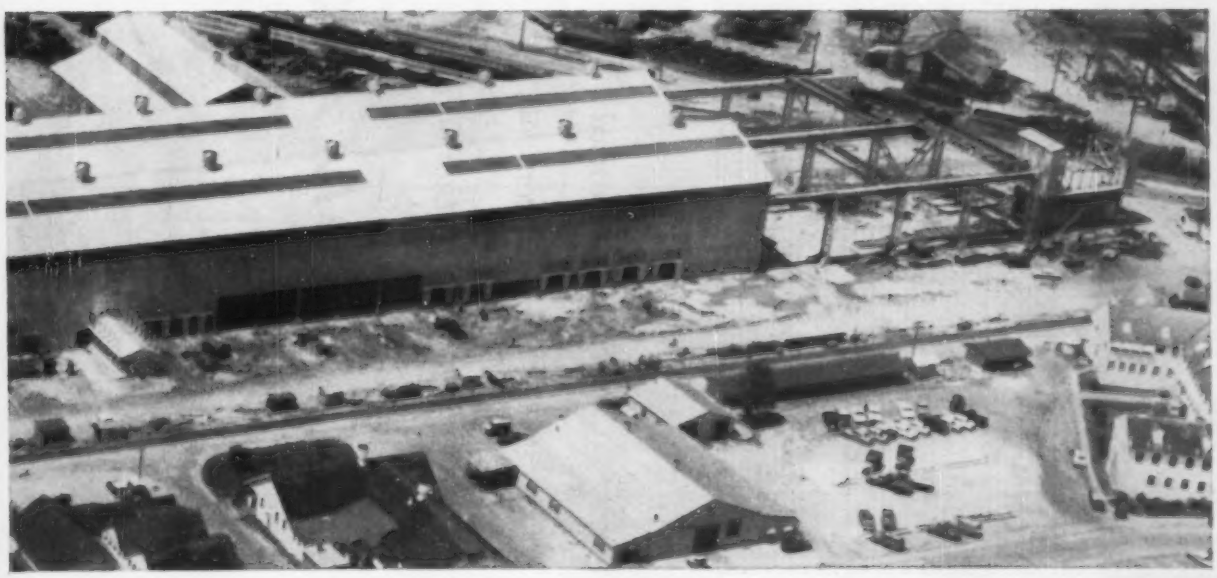
American Bridge also offers complete construction service. We have the experience, manpower and equipment to handle any plate construction work efficiently and economically.

Our Orange plant is ready to serve you now. Specialists at Orange and all other American Bridge Contracting Offices around the country are prepared to discuss your plate requirements. For high-quality, economical plate work, just get in touch with the nearest office.

USS is a registered trademark

Write for our new booklet completely describing facilities and services

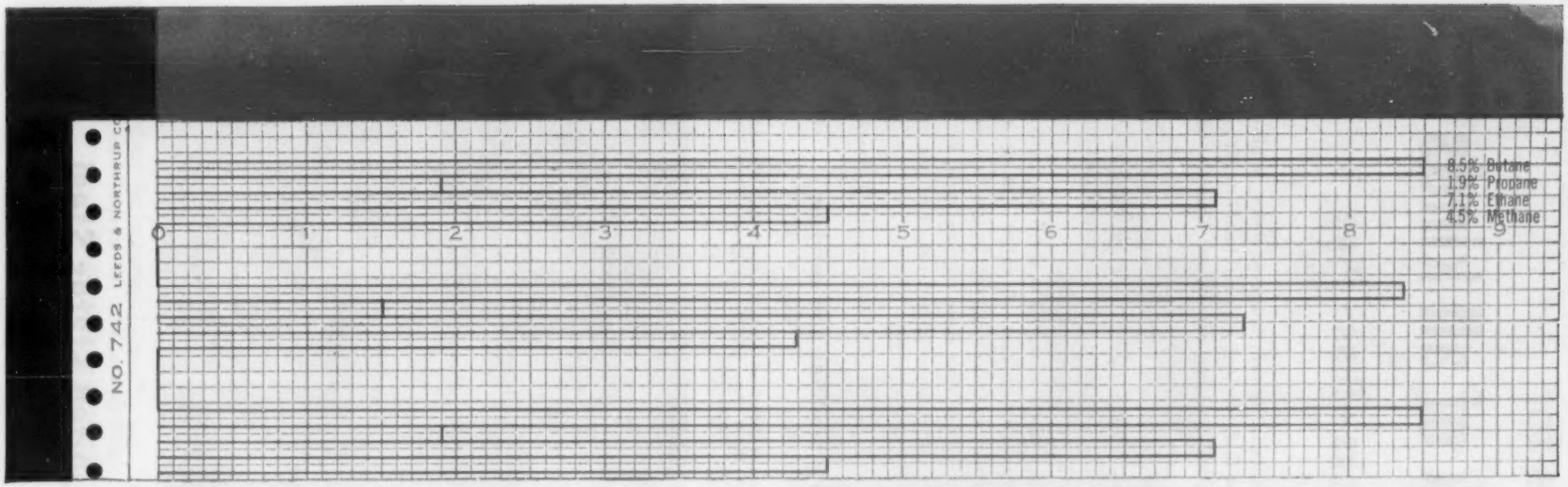
General Offices: 525 William Penn Place, Pittsburgh, Pa. Contracting Offices in: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati • Cleveland Dallas • Denver • Detroit • Elmira • Gary • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia • Pittsburgh • Portland, Ore. Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York



American Bridge Division of USS United States Steel

For more data on advertised products, use Readers' Service Cards, last page.

For more data on advertised products, use Readers' Service Cards, last page.



Prelude to advanced

process control . . .

New! electronic integration by

CHROMOMAX*

Here is the *first practical electronic integration* of process stream component analyses through Vapor Phase Chromotography. It provides an advanced concept of process monitoring and automatic control. The new "Process-Matched" Integrator, coupled with L&N's versatile Chromomax Analyzer, supplies four fresh facets to this analysis technique.

1. In process stream analysis, component concentrations are presented on a recorder chart in "wide bar display." Each bar height is proportional to the *area* of a particular component peak.

2. Each bar height varies linearly with variations in component concentration. Single-point calibration becomes more meaningful.

3. Two or more adjacent peak areas may be summed to produce an integrated value proportional to a total hydrocarbon concentration.

4. An important link to process control from V.P.C. analyses is established by this integrator. Each component measurement of peak area becomes an electrical quantity which can be used to reset control points through pneumatic or electric transmission. Analysis information can also be supplied to process computers for computations relating to ultimate process control and plant performance.

Start getting the benefits of *tomorrow's* technical advances *today*. Check with your nearest L&N Field Office for application details, or write to Leeds & Northrup Company, 4923 Stenton Ave., Phila. 44, Pa. for data.

LEEDS & NORTHRUP CO

Leeds & Northrup—the leader in Process Chromatography with "Chromomax"

*TRADEMARK

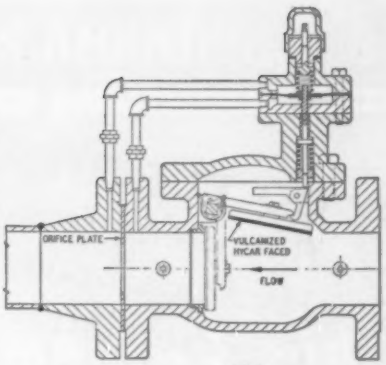
COPPUS SENTRY® VALVES

Stop flow instantly or Start flow instantly Automatically

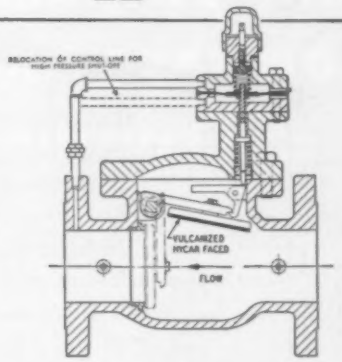
And when they flow, it's full flow

ANOTHER **COPPUS** "BLUE RIBBON" PRODUCT

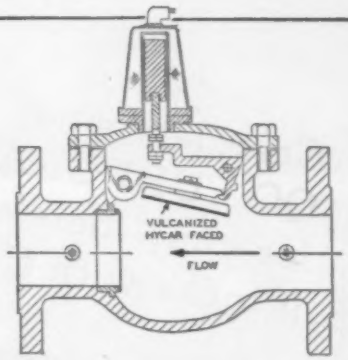
MODEL 1200 SENTRY EXCESS FLOW SHUT-OFF VALVE — shuts off gas or liquid instantly when flow exceeds predetermined rate.

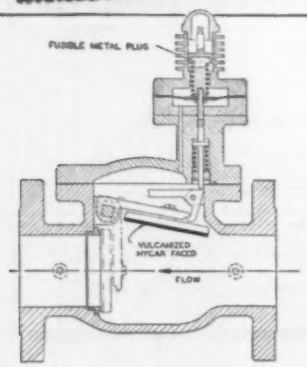


MODEL 1500H SENTRY HIGH PRESSURE AND MODEL 1500L LOW PRESSURE SHUT-OFF VALVES — shut off gas or liquid instantly when predetermined pressure limits are reached.

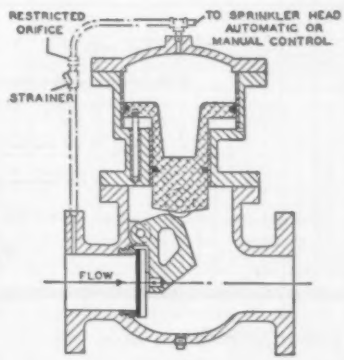


MODELS 1700 AND 1800 SENTRY SOLENOID SHUT-OFF VALVES — shut off gas or liquid instantly by remote electrical control.





MODEL 2200 SENTRY OVERPRESSURE AND OVERTEMPERATURE SHUT-OFF VALVE — shuts off gas or liquid instantly in case of excessive pressure or ambient temperature.



MODEL 3000 SENTRY PISTON OPERATED QUICK-OPENING VALVE — starts gas or liquid flow instantly when pressure in piston chamber is released. Ideal for deluge system and for automatic opening and closing by instrument-air or electrical control.

COPPUS ENGINEERING CORP.
422 PARK AVENUE
WORCESTER 10, MASS.

Please send information on Sentry Valve model 1200 ☐, 1500H and 1500L ☐ 1700 and 1800 ☐, 2200 ☐, 3000 ☐.

Name.....

Company.....

Address.....

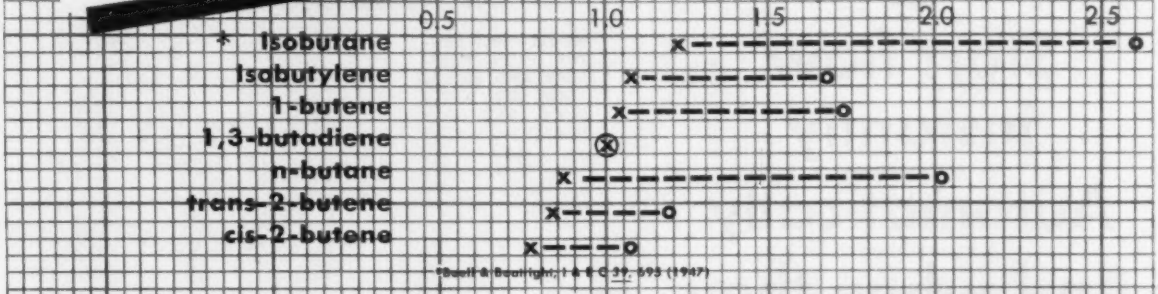
City.....

State.....

For more data on advertised products, use Readers' Service Cards, last page.

A QUAKER OATS COMPANY NEWS BULLETIN

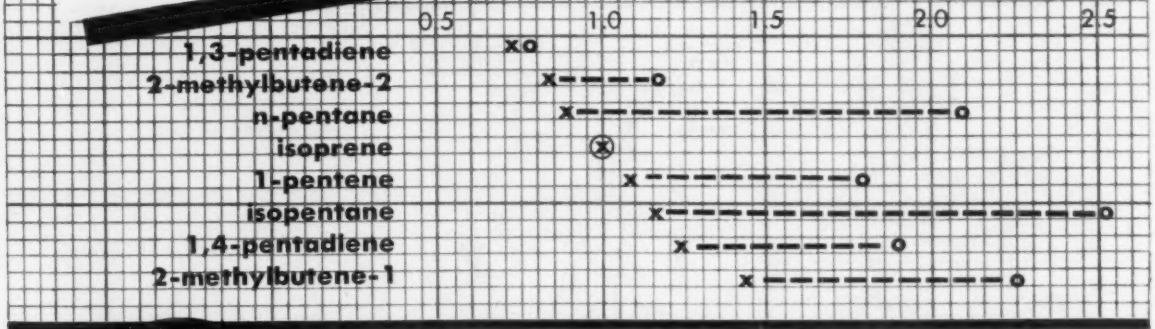
QO® FURFURAL extracts Butadiene from C_4 Hydrocarbons Commercially



X = Volatilities of C_4 hydrocarbons relative to 1,3-butadiene; of C_5 hydrocarbons to isoprene

O = Volatilities of C_4 hydrocarbons relative to 1,3-butadiene in furfural plus 4% water; of C_5 hydrocarbons to isoprene in furfural plus 4% water

Calculate what QO FURFURAL can do for you...here's how it looks with C_5's.



The Quaker Oats Company — CHEMICALS DIVISION — QO FURFURAL CHEMICALS

Write for information to—

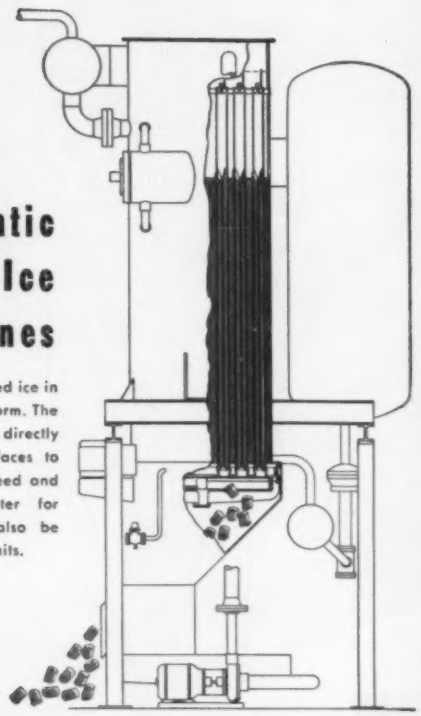
The Quaker Oats Company
CHEMICALS DIVISION
340E The Merchandise Mart, Chicago 54, Illinois

For more data on advertised products, use Readers' Service Cards, last page.

GET AHEAD with . . . "YEARS-AHEAD" . . .

Automatic Tube-Ice Machines

Make clear, hard, sized ice in cylinder or crushed form. The refrigerant is applied directly to the freezing surfaces to produce ice with speed and economy. Cold water for process work can also be supplied by these units.



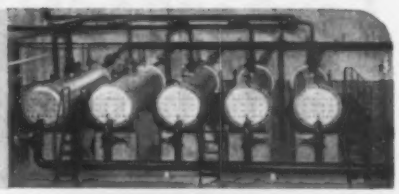
Vogt

ICE MAKING and REFRIGERATING EQUIPMENT

. . . for the preservation of foods and beverages during process and in storage. Petroleum refineries, chemical plants, and related industries also employ this equipment in various processes. In addition to equipment shown here, we manufacture liquid receivers, pipe coils, and valves, fittings, and flanges, for refrigeration as well as for high pressures and temperatures. Bulletins on request. Address Dept. 24A-RIPR.

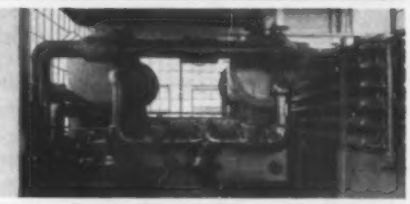
Refrigeration Condensers

Available in horizontal multipass shell and tube types and vertical single pass types for Ammonia or other refrigerants. Special metals, lined tubes, etc. can be furnished for unusual operating conditions.



Brine Coolers

Multipass type brine coolers are ideal for closed brine systems in cold storage plants, dairies, packing plants, petroleum refineries, etc. requiring units of large capacity. Also suitable for cooling non-corrosive liquids in general.



Scraped Surface Exchangers

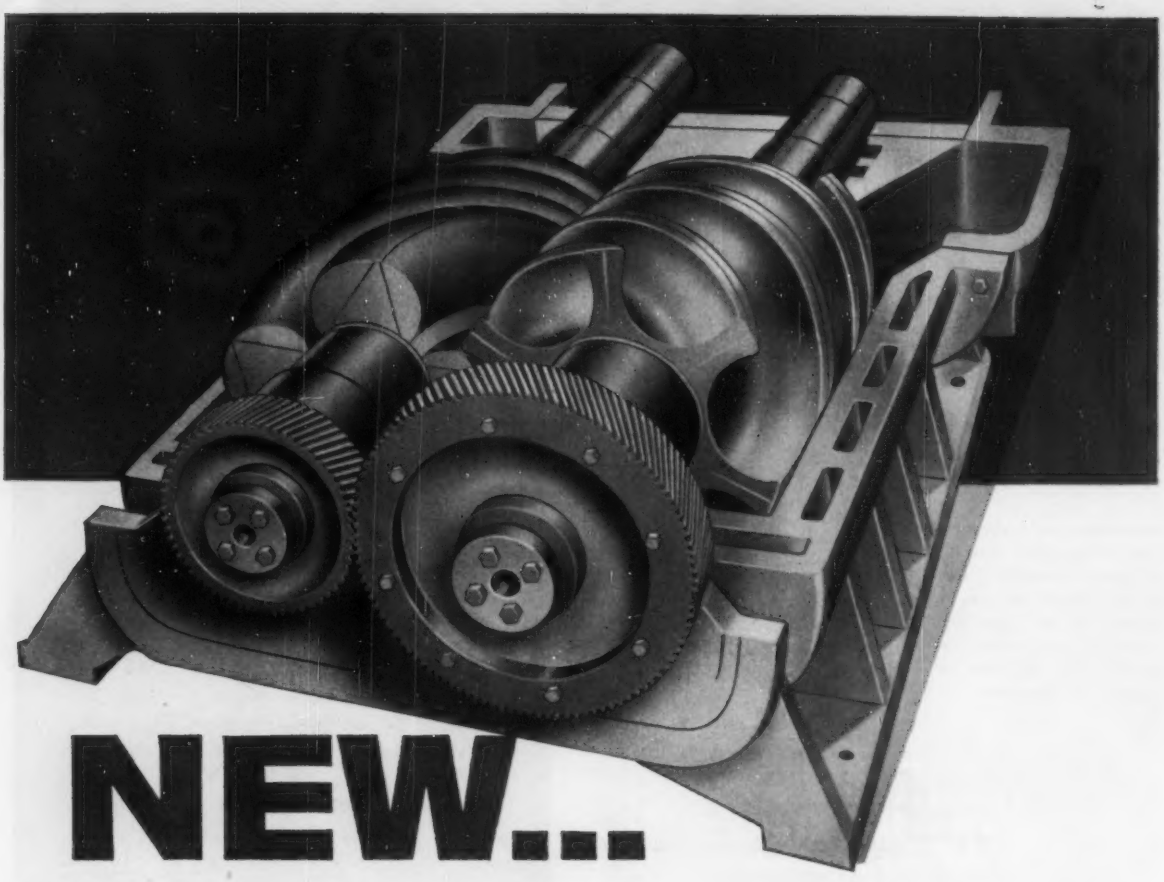
Continuously revolving scrapers sweep heat transfer surfaces clean and keep solids in suspension. Useful in problems of heat transfer with crystallization with high viscosity, or with solvent extraction. Available in double pipe and shell and pipe construction.

HENRY VOGT MACHINE CO., Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati

OTHER VOGT PRODUCTS DROP FORGED STEEL VALVES, FITTINGS AND FLANGES IN A COMPLETE RANGE OF SIZES • PETROLEUM REFINERY AND CHEMICAL PLANT EQUIPMENT • STEAM GENERATORS

For more data on advertised products, use Readers' Service Cards, last page.



NEW...

Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressor

Combines the best features of reciprocating and centrifugal compressors

Consider the advantages of the all-new Fairbanks-Morse two-impeller, helical-lobe type, axial-flow rotary compressor:

1 Delivers oil-free air or gas with low ratios of unit weight and space to capacity.

2 Exhibits high efficiencies and positive-displacement stability of flow at varying compression ratios and speeds.

Result: Ideal performance from a relatively small compressor that is mechanically simple, flexible in application, adaptable to any power source; a compressor that provides stable performance, smooth operation, and variable-capacity control.

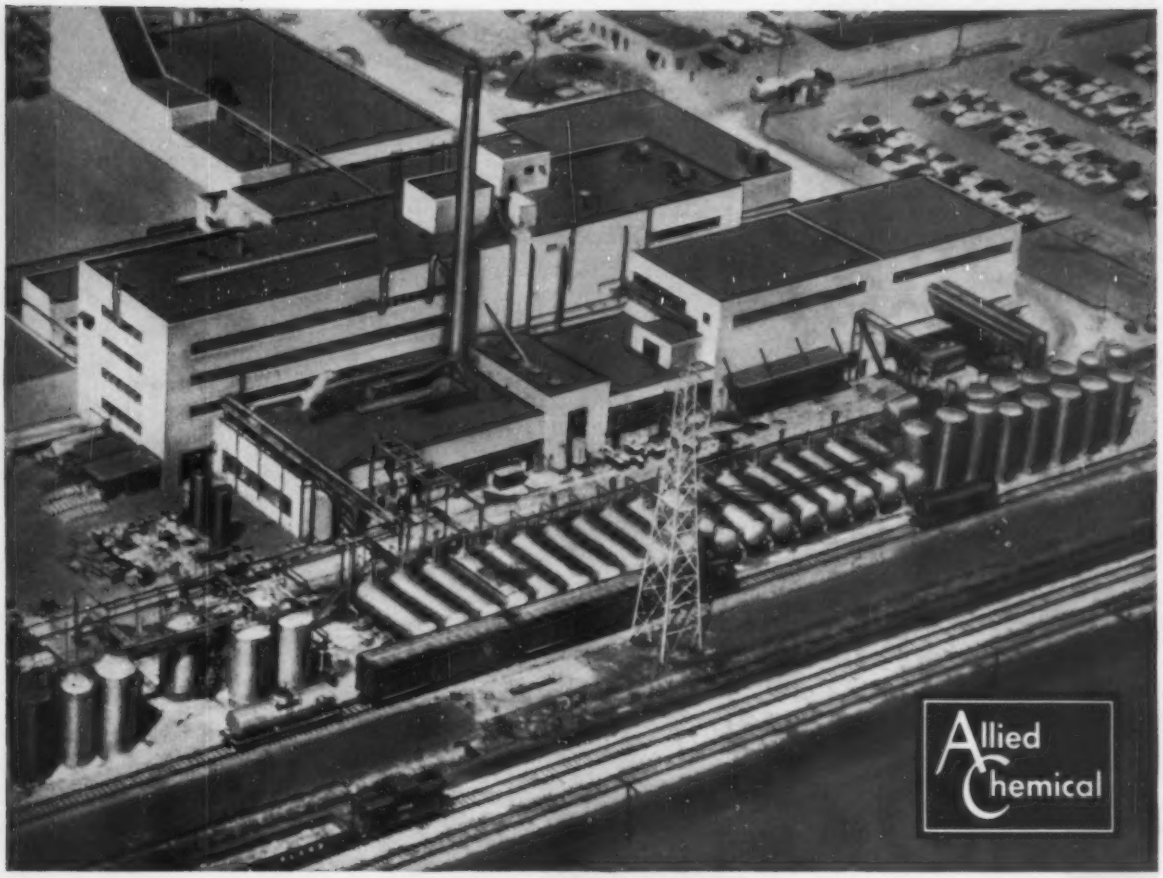
This all-new F-M Compressor is available in 5 standard case and impeller sizes, single-stage and multi-stage units—for pressure, vacuum or booster service. Capacities range from 800 to 13,000 cfm.—also higher or lower if desired, on custom-designed basis. Contact your Fairbanks-Morse branch for further information, or write directly to Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.

Ask for new illustrated bulletin ACO 100.1 giving typical performance characteristics and other important data.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS • ELECTRICAL MACHINERY • DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • MAGNETOS



Polyester and Phenolic Resins Plant—Toledo, Ohio
Plastics and Coal Chemicals Division, Allied Chemical Corporation

COORDINATION COUNTS

The Plastics and Coal Chemicals Division required installation of its new Polyester and Phenolic Resins facilities without plant shutdown or interruption of other production.

Synchronizing its operations with those of the client, Catalytic completed the job as required . . . ahead of time and under the budget.

With Catalytic—On Time—On Budget is far more than just a slogan.

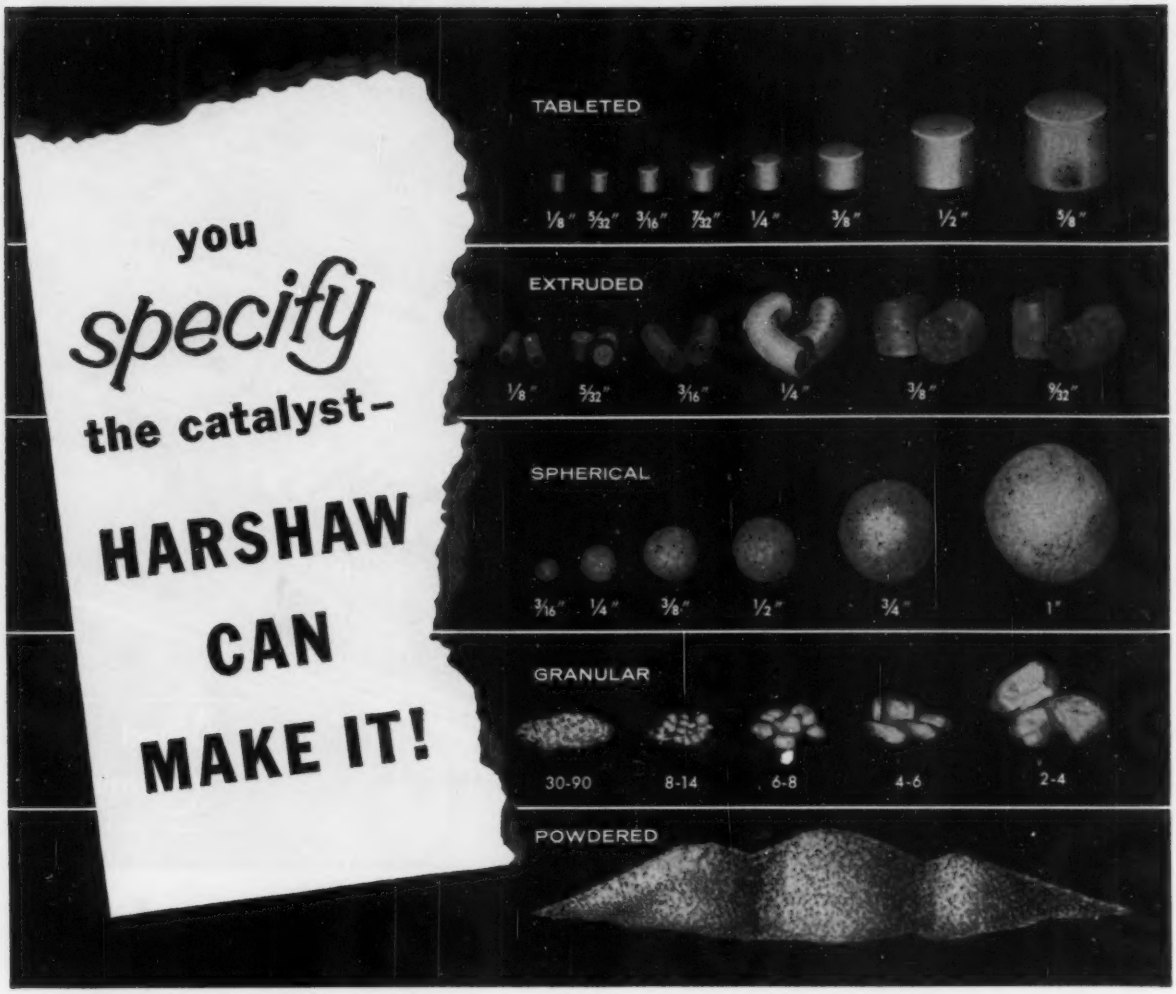
CATALYTIC
CONSTRUCTION COMPANY

Philadelphia 2, Pennsylvania
New York, New York
Baton Rouge, Louisiana
Toledo, Ohio
Tulsa, Oklahoma

In Canada: Catalytic Construction of Canada, Limited; Sarnia, Ontario; Toronto, Ontario; Montreal, Quebec.

Catalytic *On-Time* . . . *On-Budget* Services for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction.

For more data on advertised products, use Readers' Service Cards, last page.



HARSHAW

has the facilities for producing carload quantities of

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydration
Cyclization	Desulphurization
Oxidation	Alkylation
Dehydrogenation	Isomerization

Hydrogenation

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

Write for FREE Booklet, "HARSHAW CATALYSTS"

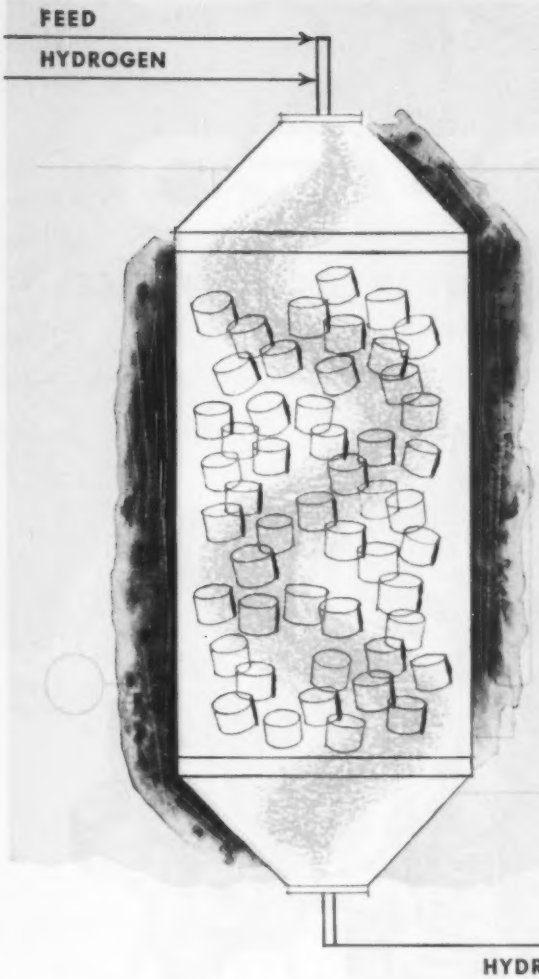
HARSHAW

THE HARSHAW CHEMICAL CO.

1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Hastings-On-Hudson, N.Y. • Houston • Los Angeles
Detroit • Philadelphia • Pittsburgh

For more data on advertised products, use Readers' Service Cards, last page.



FOR HYDROTREATING:

6/10¢

PER BARREL ACCUMULATED CATALYST COSTS ON A DIFFICULT-TO-TREAT, HIGH SULFUR, HIGH NITROGEN STOCK, USING HARSHAW COBALT MOLYBDATE CATALYST*

Consistently low catalyst costs for hydrotreating, using Harshaw Cobalt Molybdate Catalyst, are possible because the inherent ruggedness and high thermal stability of our catalyst permits repeated regenerations while maintaining full activity—in one instance *223* regeneration cycles without loss in activity.

This versatile Harshaw catalyst performs efficiently over a wide range of feedstocks—from low boiling naphthas to heavy coker distillates. In all applications, the long life of our catalyst reflects reduced per-barrel costs.

For further information contact the Harshaw Branch nearest you. Our representative will be happy to discuss with you the application of Harshaw Cobalt Molybdate Catalyst to your operation.

*Based on an actual customer experience to date in a specific unit still operating. Its continuing operation will further reduce the 6/10¢ per barrel cost.

HARSHAW

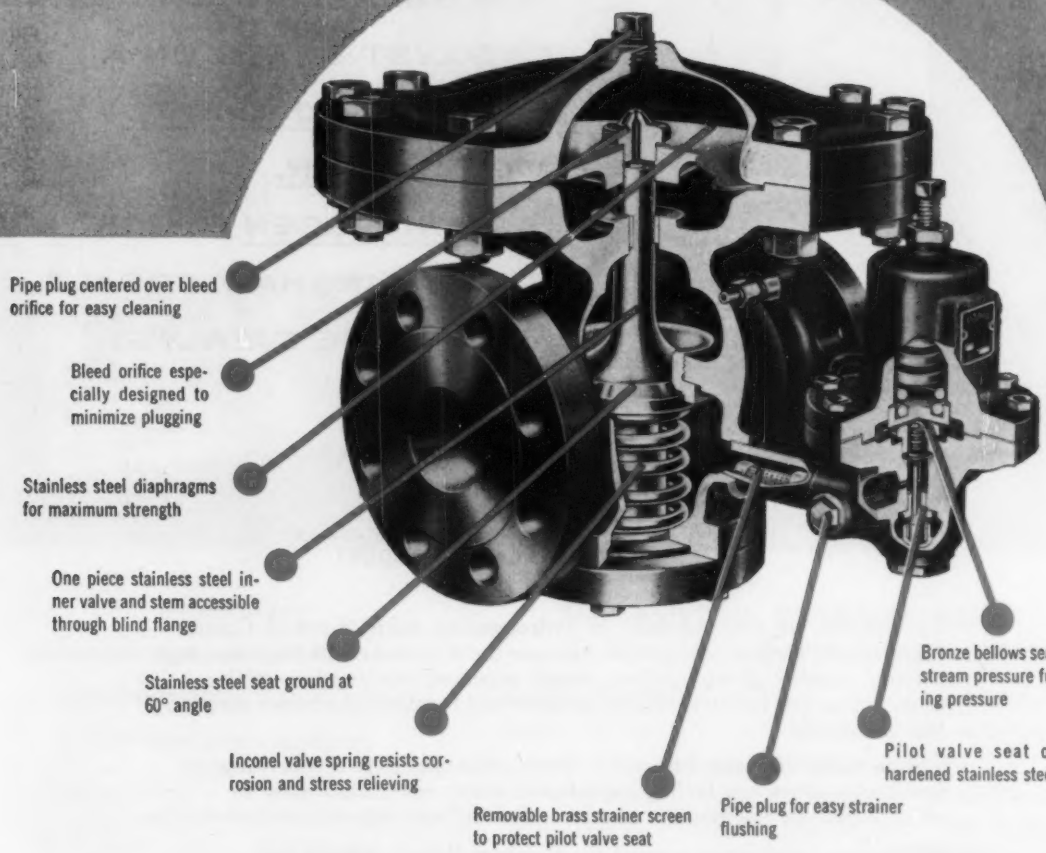
THE HARSHAW CHEMICAL CO.

1945 E. 97th STREET • CLEVELAND 6, OHIO

CHICAGO
CINCINNATI
CLEVELAND
DETROIT
HASTINGS-ON-HUDSON
HOUSTON
LOS ANGELES
PHILADELPHIA
PITTSBURGH

For more data on advertised products, use Readers' Service Cards, last page.

THE FISHER® 92B
IMPROVED
TO MINIMIZE PROBLEMS INHERENT IN STEAM SERVICE


Pipe plug centered over bleed orifice for easy cleaning
Bleed orifice especially designed to minimize plugging
Stainless steel diaphragms for maximum strength
One piece stainless steel inner valve and stem accessible through blind flange
Stainless steel seat ground at 60° angle
Inconel valve spring resists corrosion and stress relieving
Removable brass strainer screen to protect pilot valve seat
Pipe plug for easy strainer flushing
Pilot valve seat of hardened stainless steel
Bronze bellows seals downstream pressure from loading pressure

Not content with the enviable performance record of the Type 92A, Fisher engineers have improved this pilot operated pressure reducing valve to a new peak of performance.

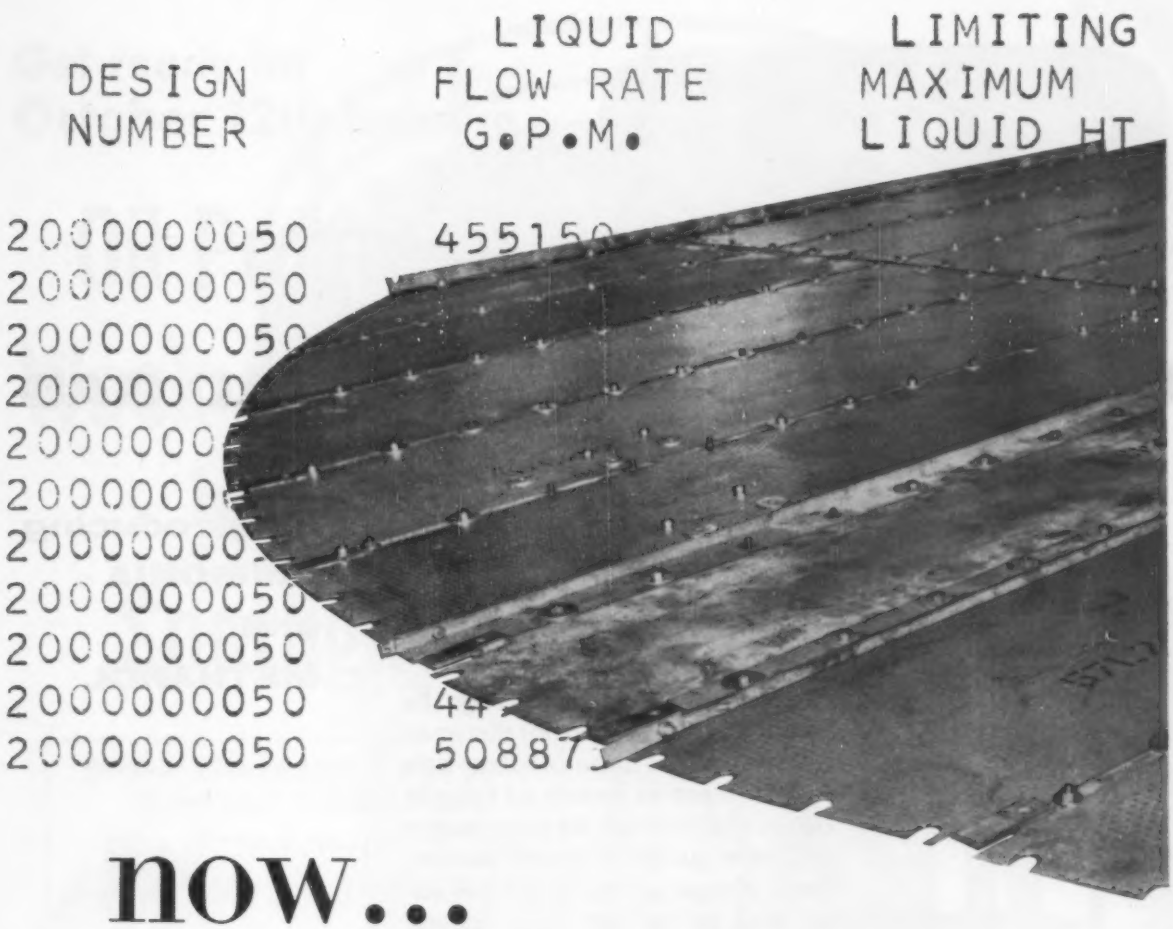
For extremely accurate, long trouble-free service, put a Fisher 92B in the line. One pilot with three interchangeable springs provides a range of from 2 to 150 psi. • *Send for Bulletin D-92 today.*

Engineers with special problems . . . find the ***answer*** *in . . .*

FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

For more data on advertised products, use Readers' Service Cards, last page.



now...

HENDRICK PERFORATED TRAYS ARE COMPUTER DESIGNED AND RATED!

Process designers in the Refining, Petrochemical and Chemical Industries take notice! With Hendrick's new *Computer Design* method all you do is feed us your vital statistics . . . we in turn feed them to an electronic computer . . . The result? A set of design specifications that suit your distillation column internal requirements to a "T."

Computer Designed Hendrick Perforated Trays have a lower initial cost, higher vapor thru-put, higher efficiency and less entrainment. And that's not all! Hendrick trays are easy to maintain . . . really afford simpler tower construction . . . ensure a wide range of stable operation . . . and you save in the diameter of columns required for a specified process capacity.

In corrosive services, a *Computer Designed* tray of stainless steel or other corrosive-resistant metal is the answer! You'll not only reduce frequent replacement costs but you'll cut losses in production caused by time-wasting change-overs and expensive cleaning.

Hendrick is licensed to manufacture ESSO "Jet-Trays," SOCONY "Uniflux," SHELL "Turbo-Grid" and STONE and WEBSTER "Ripple Trays." Hendrick is also equipped to supply all types of trays to specifications.

Hendrick

MANUFACTURING COMPANY

Perforated Metal • Perforated Metal Screens • Wedge Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer • Distillation Column Internals

Hendrick Manufacturing Company
36 Dundaff Street, Carbondale, Penn.

_____Please send FREE Bulletin CI-2
_____Please send FREE General Catalog No. 58
_____Have representative call

Gentlemen:

Title_____ Name_____

Company_____

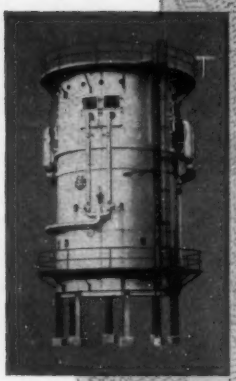
Address_____

State_____ City_____

For more data on advertised products, use Readers' Service Cards, last page.

HYDROGEN FROM NATURAL GAS

for producing AMMONIA and METHANOL



Since its introduction ten years ago, the Chemico *gas reform furnace* has often proved the most efficient and economical first step in the production of ammonia, methanol and high purity hydrogen from natural gas. The unique design of the Chemico *gas reform furnace* eliminates thermal expansion problems, assures easy control during operation and requires minimum maintenance.

Now there are more than 60 furnaces in operation, and another 10 are in the design or construction stage. These units range in capacity from 50,000 to 8,000,000 standard cubic feet per day of hydrogen plus carbon monoxide. For any process which requires hydrogen, the Chemico *gas reform furnace* may well prove the most economical means of obtaining the necessary quantities. Write to Chemico for further information.

WRITE TODAY FOR A COPY OF THE NEW CHEMICO GENERAL BULLETIN

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

CHEMICO

CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

Get ready for October 12th because...

Oil Progress Week puts YOU in the Spotlight!

October 12th to 18th is your week to tell your neighbors that

"TODAY—OIL BUILDS for your TOMORROW"

You have a wonderful Oil Progress Week story to tell in 1958. It's personal and timely. This year's story is an expression of the oil industry's confidence in America's future. Americans everywhere will know that *you*—and everyone else in the oil industry—are looking ahead, building *today* for a better *tomorrow*.

You'll have plenty of help

The Oil Information Committee has a wealth of attractive, professionally-prepared materials available for your use. There are commercials, films and speeches for radio and television, window posters, exhibits and demonstrations, *plus* a complete mat book filled with advertisements that any oilman can use. And all these materials are *free!*

A great way to get started is to contact your local Oil Information Committee Chairman. He will be happy to help you plan a program that will work for you in your own community.

Clip this coupon now for complete information about Oil Progress Week.

American Petroleum Institute, Dept. G
50 W. 50th Street, New York 20, N. Y.

I want to take part in promoting Oil Progress Week in my town. Please send me your FREE booklet explaining Oil Progress Week activities and listing the materials available to me.

NAME _____

ADDRESS _____

CITY _____ **ZONE** ____ **STATE** _____

For more data on advertised products, use Readers' Service Cards, last page.

HUDSON Combin-aire

LOW TEMPERATURE COOLING USING COMBINATION OF MINIMUM WATER AND MAXIMUM AIR

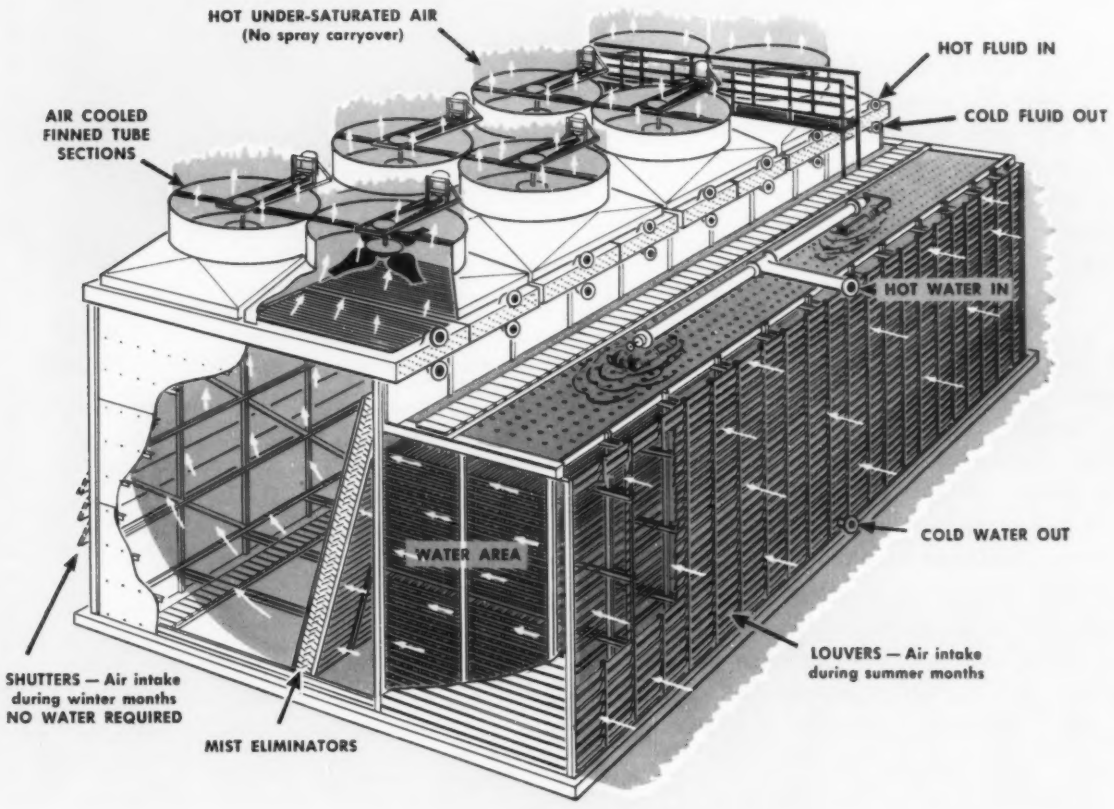
In recent years Hudson Solo-aire cooling in which only air is used as a cooling medium has been installed by the world's largest refineries. In recent cases of three separate 40,000 barrel complete refineries in locations where unlimited water is accessible Hudson Solo-aires are used for *all* process cooling.

So that air could be used for cooling those process streams requiring lower terminal temperatures than obtainable with ambient summer air temperatures, Hudson developed and in 1949 installed the first Combin-aire cooling unit. Since that time Combin-aires have proven their worth in installations for over 80 services in major refineries, chemical plants and gas processing plants in the United States, the Middle East, Europe, Mexico and South America.

In Combin-aire cooling, high temperature ambient air is first pre-cooled by direct contact with water, the cooled air then becoming the low temperature cooling medium for fin-tube elements. Cooling of air, and subsequent use of the cooled air for fin-tube cooling of process streams, are effected in one integrated structure — the Combin-aire.

Cooling with Combin-aire to overcome the occasional limitation of high ambient temperatures has the following advantages:

- **Absolute minimum water consumption consistent with attainment of low terminal process stream temperatures.**
- **Water circulation may be made automatically responsive to air temperatures with no water circulated except at high ambient temperature.**
- **No water treatment necessary. Salt water or brackish water may be used.**
- **No spray carryover or condensation. After passing across the fin-tube elements the heated air leaving the Combin-aire at elevated temperature is undersaturated with water vapor and cannot precipitate condensate or carry water spray.**
- **Minimum piping. Combin-aire may be installed immediately adjacent to other process equipment.**
- **Clean air to fin-tube units. During the hot season water is washed, removing dust, sand and insects.**


HOT UNDER-SATURATED AIR
(No spray carryover)
HOT FLUID IN
COLD FLUID OUT
AIR COOLED FINNED TUBE SECTIONS
HOT WATER IN
WATER AREA
COLD WATER OUT
LOUVERS — Air intake during summer months
SHUTTERS — Air intake during winter months NO WATER REQUIRED
MIST ELIMINATORS

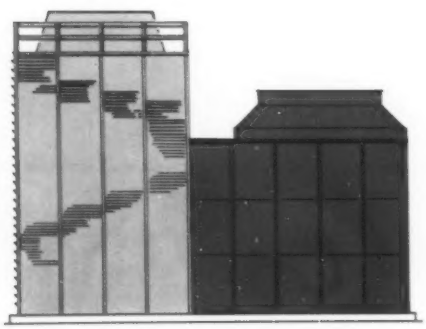
When Combin-aires are installed as adjuncts to cooling systems using existing shell and tube or other water cooled equipment the cooled water from the bottom of the Combin-aire may be used in such equipment. The Combin-aire then takes on the additional function of a water cooling tower with, however, the advantages over conventional cooling towers of dual use of both air and water and elimination of water spray carryover and condensate precipitation.

In over 80 services and under a wide range of atmospheric operating conditions Combin-aire units have amply fulfilled performance and mechanical specifications. Before proceeding with a new process unit or revamping or adding to present cooling systems let Hudson give objective assistance in determining the most economic balance in the use of air cooling, Combin-aire cooling and water cooling.

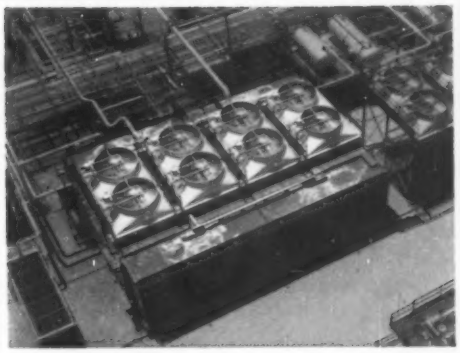
CONVERTING COOLING TOWERS INTO COMBIN-AIRE UNITS

Presently installed cooling towers may be used as the basis for Combin-aire cooling by installing structure with fin-tube elements and fans immediately adjacent to the cooling tower with air for the fin-tube elements being drawn across the water near the bottom of the cooling tower, thus increasing the capacity of the cooling tower, and cooling the air for use in the fin-tube elements.

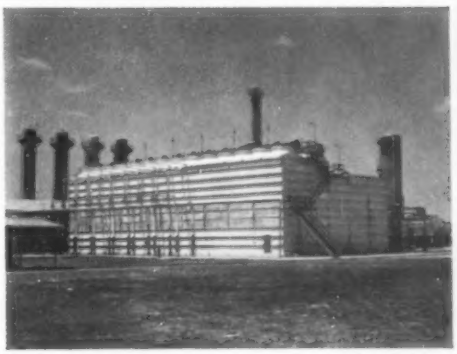
EXISTING COOLING TOWER — **COMBIN-AIRE ADDITION**



Combin-aire is protected by U. S. Patents, Patents pending and copyrights.



TEXAS —
COSDEN PETROLEUM CORPORATION
Big Spring, Texas



MEXICO —
PETROLEOS MEXICANOS
Reynosa, Tamaulipas, Mexico

PAKISTAN —
PAKISTAN PETROLEUM, LTD.
Sui gas field, West Pakistan

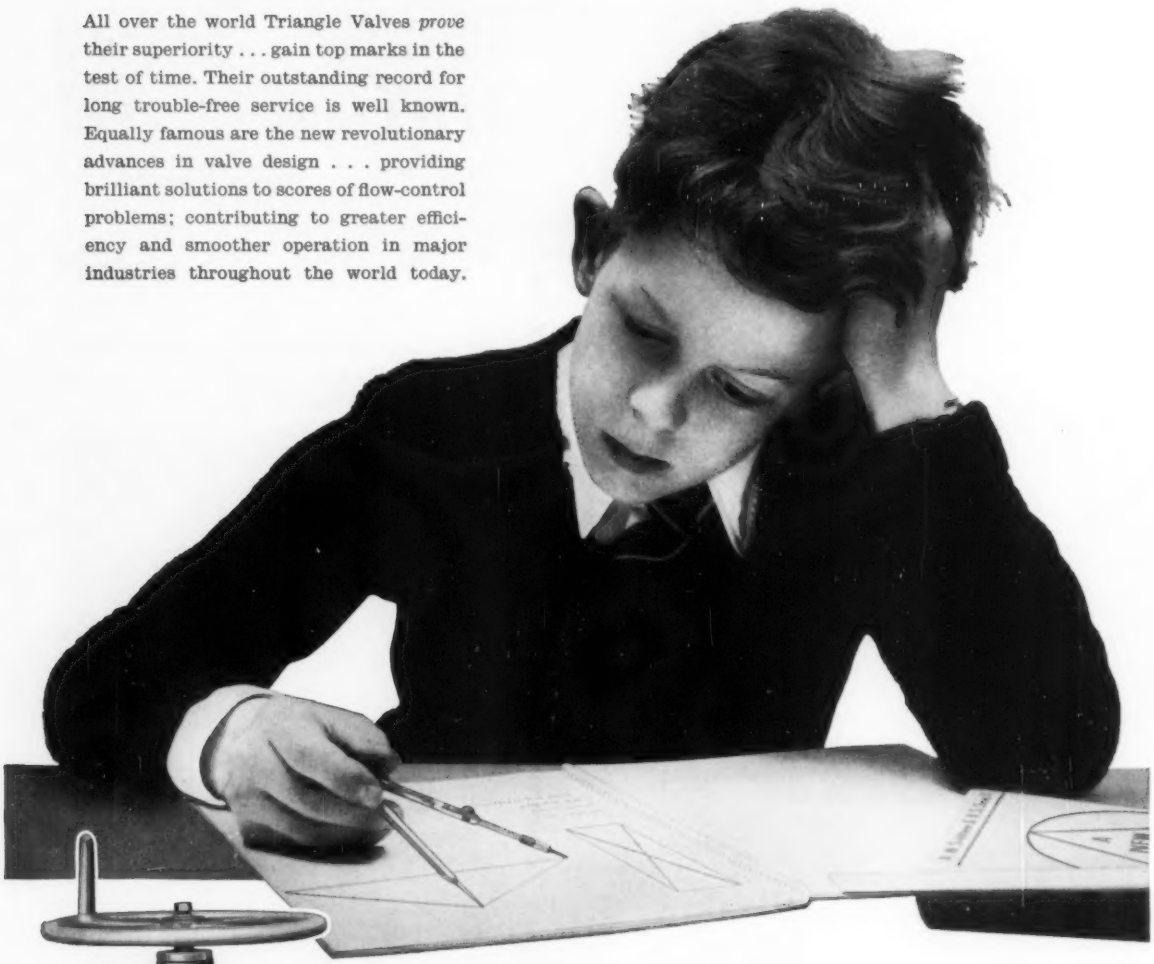
HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS

SALES OFFICES:
9935 Santa Monica Blvd. Beverly Hills, California • 122 East 42nd St. New York, 17, N. Y. • 199 Bay Street Toronto, Ontario, Canada
17 Stratton St., Picadilly London W. 1, England • Corrientes 1115 Buenos Aires, Argen. • Rua Mexico 45 Rio de Janeiro, Brazil

HUDSON COOLING EQUIPMENT MANUFACTURED UNDER LICENSE BY:
A. F. Craig & Co., Ltd. Paisley, Scotland • Batignolles-Chatillon 5 Rue de Monttessuy Paris, France

Quod Erat Demonstrandum

All over the world Triangle Valves *prove* their superiority . . . gain top marks in the test of time. Their outstanding record for long trouble-free service is well known. Equally famous are the new revolutionary advances in valve design . . . providing brilliant solutions to scores of flow-control problems; contributing to greater efficiency and smoother operation in major industries throughout the world today.



The new Triangle Wellhead Valve is one of the latest additions to a range of the most advanced designs available. It is specially constructed to withstand tremendous pressures of up to 5,000 lbs. per square inch.

Triangle Valve CO. LTD.

LAMBERHEAD GREEN, WIGAN

Suppliers of Valves to:
Royal Dutch Shell Group of Oil Companies • Esso Petroleum Co. Caltex Services • Standard Vacuum Oil Co. • British Petroleum Co. Iranian Oil Services Ltd. • Aramco Overseas Co. • Iraq Petroleum Co. Ltd. • Petrochemicals Ltd. • Mobil Oil Co. Ltd. • Imperial Chemical Industries Ltd. • Distillers Co. Ltd., *and many others.*

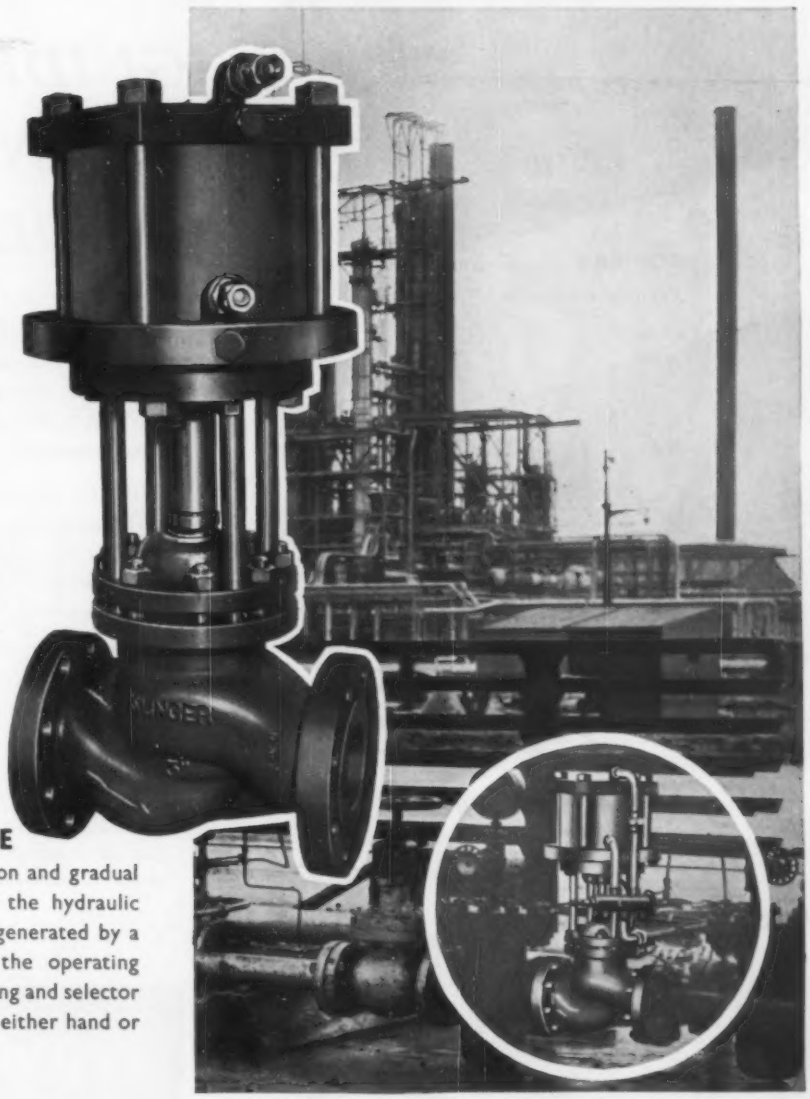
Agents throughout the world: **Th. J. Van Den Anker, VICTORIEPLEIN 17, Amsterdam. Etablissements A. Bruyaux, S.A., 244-246, Rue de la Loi, BRUSSELS, Belgium. Mario D'Orsi, Via Napo Torriani, 1, MILAN, Italy • The Grinnell Company of Canada Ltd., 2440 Dundas Street West, TORONTO 9, Canada • Triangle Valve (Australia) Pty. Ltd., Sussex Street, COBURG N.14, Melbourne, Australia.**

For more data on advertised products, use Readers' Service Cards, last page.

Klingermatic

REMOTE CONTROL PISTON VALVES

AIR & HYDRAULIC OPERATED



The Klinger Piston Valve readily lends itself to remote control by air and hydraulic operation, and as such Klingermatic Air or Hydraulically Operated Valves are ideally suited for remote control of filling lines, emergency valves, drop-out valves, etc.

AIR-OPERATED VALVE
gives a rapid opening and closing. Control of the valve is provided by a small hand-operated valve or push button, which can be situated 100 ft. or more away. A number of valves can be operated simultaneously by the same control, or a single valve can be controlled from more than one station.

HYDRAULIC-OPERATED VALVE
gives positive control in any position and gradual opening and closing. Control of the hydraulic valve is provided by oil pressure, generated by a pump, which is transmitted to the operating cylinders through metering, reversing and selector valves. The selector valves can be either hand or electrically operated.

THE KLINGER CORPORATION OF AMERICA, 95 RIVER STREET, HOBOKEN, NEW JERSEY
Telephone: OLDFIELD 6-1300.

Manufacturing Licensees for Canada
JOSEPH ROBB & COMPANY LIMITED, 5575, COTE ST. PAUL ROAD, MONTREAL, 20, CANADA
Telephone : GLENVIEW 9151
Branches at: SYDNEY, HALIFAX, OTTAWA, TORONTO, HAMILTON, WINNIPEG, EDMONTON, VANCOUVER, QUEBEC CITY

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND.

GA45/58/KM

NEWALLS *present an* *ABC* *GUIDE TO REFINERY INSULATION*

Aden, Bombay, Cuba—we could equally well start with Amuay, Antwerp, Bahrain, Cardon, Cubatao—or go back to Abadan—or even to Astra-Romana of the 1920's, then on through some 40 oil refineries to Visakhapatnam.

Wherever oil is to be refined you are likely to find Newalls insulation. As one of the world's largest heat insulation manufacturers and contractors, Newalls have contributed extensively to thermal efficiency in this highly specialised field for over 25 years.

Newalls supply a range of insulating materials to operate at temperatures from —300°F. up to over 2,000°F. that have proved themselves in oil refineries and petrol-chemical plants in most countries.

Newalls also provide a Technical Advisory Service with long experience of all types of insulation questions from design to completion.

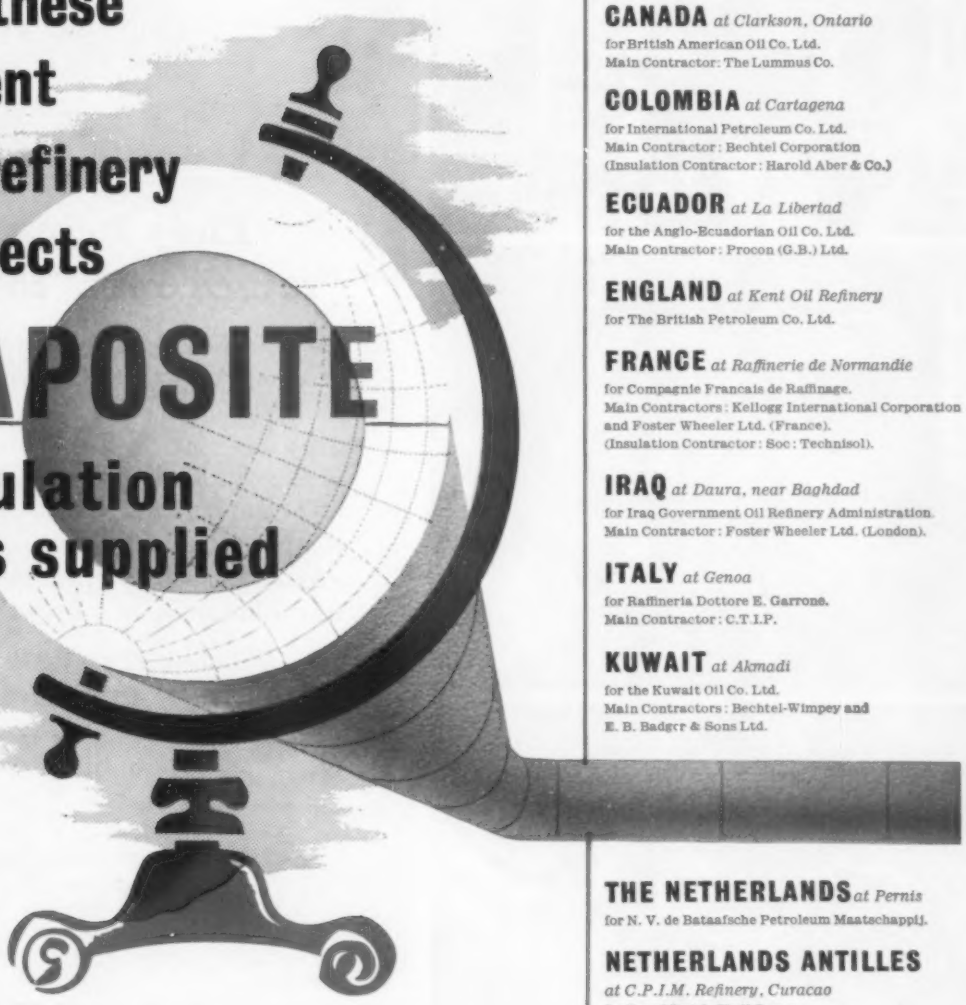
Newalls

NEWALLS INSULATION CO. LTD.
Head Office:
Washington, County Durham, England
A member of the TURNER & NEWALL ORGANISATION
AGENTS AND VENDORS IN MOST MARKETS ABROAD

For more data on advertised products, use Readers' Service Cards, last page.

for these recent oil refinery projects

CAPOSITE insulation was supplied



BAHRAIN *at Awali*
for Bahrain Petroleum Co. Ltd.
Main Contractor: Foster Wheeler Ltd.

BURMA *at Syriam*
for The Burma Oil Co. (1954) Ltd.
Main Contractor: Foster Wheeler Ltd. (London)

CANADA *at Clarkson, Ontario*
for British American Oil Co. Ltd.
Main Contractor: The Lummus Co.

COLOMBIA *at Cartagena*
for International Petroleum Co. Ltd.
Main Contractor: Bechtel Corporation
(Insulation Contractor: Harold Aber & Co.)

ECUADOR *at La Libertad*
for the Anglo-Ecuadorian Oil Co. Ltd.
Main Contractor: Procon (G.B.) Ltd.

ENGLAND *at Kent Oil Refinery*
for The British Petroleum Co. Ltd.

FRANCE *at Raffinerie de Normandie*
for Compagnie Francais de Raffinage.
Main Contractors: Kellogg International Corporation and Foster Wheeler Ltd. (France).
(Insulation Contractor: Soc: Technisol).

IRAQ *at Daura, near Baghdad*
for Iraq Government Oil Refinery Administration.
Main Contractor: Foster Wheeler Ltd. (London).

ITALY *at Genoa*
for Raffineria Dottore E. Garrone.
Main Contractor: C.T.I.P.

KUWAIT *at Akmadi*
for the Kuwait Oil Co. Ltd.
Main Contractors: Bechtel-Wimpey and E. B. Badger & Sons Ltd.

THE NETHERLANDS *at Pernis*
for N. V. de Bataafsche Petroleum Maatschappij.

NETHERLANDS ANTILLES
at C.P.I.M. Refinery, Curacao
for Royal Dutch-Shell Group.

SCOTLAND *at Grangemouth*
for British Hydrocarbon Chemical Co. Ltd.
Main Contractor: E. B. Badger & Sons Ltd.

VENEZUELA *at Maracaibo*
for The Richmond Exploration Co.
Main Contractor: The Lummus Co.

CAPOSITE regd.

Amosite Asbestos Blocks and Pipe Sections

Speedy application .... long-lasting protection .... resilience to withstand rough handling .... long fibred Amosite asbestos, giving superior insulating properties — these are the reasons why CAPOSITE is being specified for more and more of today's refineries.

CAPOSITE *is also manufactured in* SOUTH AFRICA, ITALY, CANADA, FRANCE, HOLLAND, SPAIN

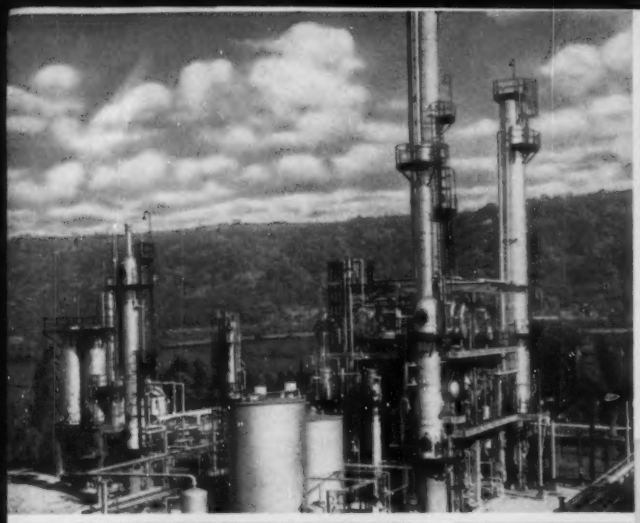
THE CAPE ASBESTOS COMPANY LTD
114 & 116 PARK STREET, LONDON, W.1
Tel: GROsvenor 6022 Cables: Incorrupt London

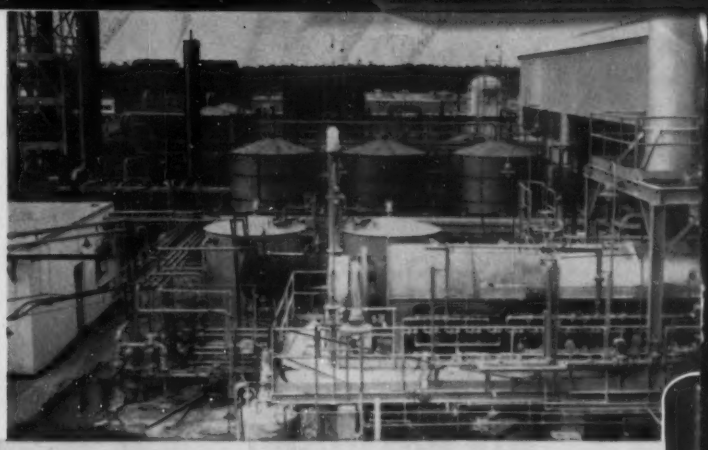
Enquiries in Canada to:
Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.
U.S.A. to: North American Asbestos Corpn., Board of Trade Building, Chicago, 4, Illinois

CAPE

TA 415

For more data on advertised products, use Readers' Service Cards, last page.





They bring the "tough ones" to Badger

On these two pages are shown a few of the difficult projects successfully completed by Badger during the past year.

They were tough, but we did them. As a result of accomplishments like these, Badger's growth in '57 was double the previous year's.

Now, we think we have earned the right to an easy assignment. *You* have the right to think that if Badger can do the tough ones so well,

Badger can do the easy ones better, too

It's worth investigating — and easy. Key Man Service can be yours in a matter of hours — call or write today!

AIChE

1958 — GOLDEN ANNIVERSARY

Congratulations from Badger on 50 years of achievement. All the Directors of Badger Manufacturing Company are Members of the Institute.

BADGER

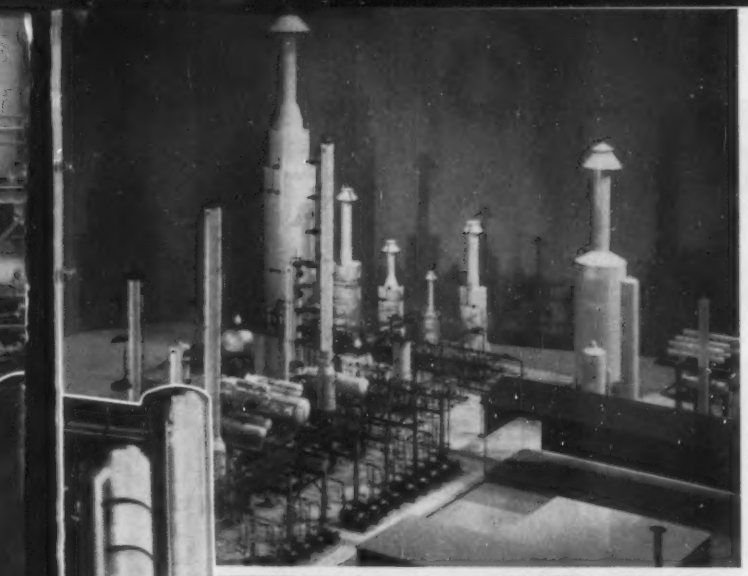
MANUFACTURING COMPANY

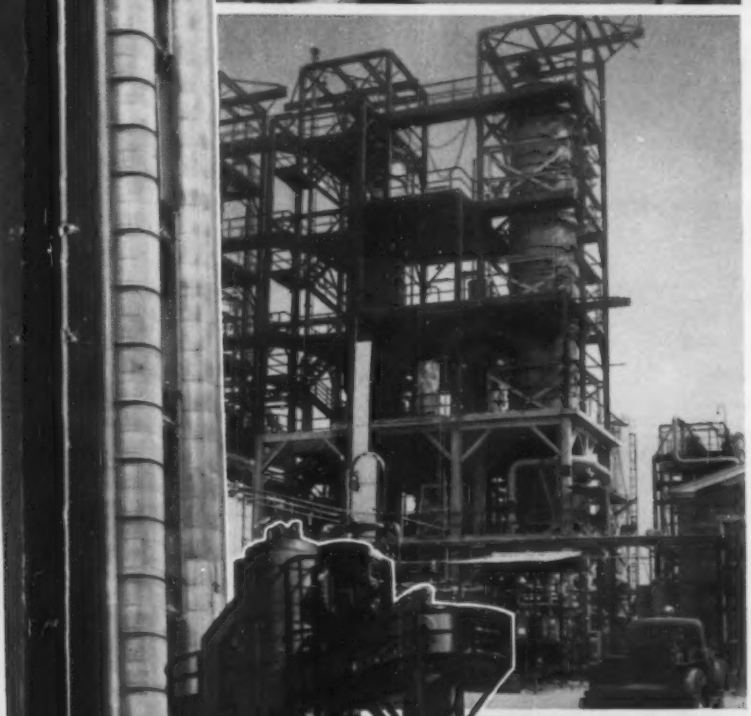
ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS

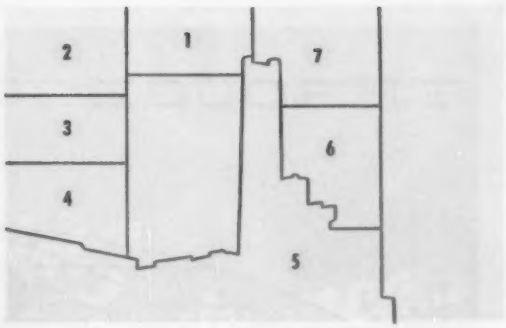
230 Bent St., Cambridge, Mass. • New York, N. Y. • Houston, Texas

IN EUROPE: Badger-Comprimo N. V., The Hague

Badger-Comprimo S. A., Antwerp







1 **Columbia-National Corp., Pensacola, Fla.** This plant, engineered and constructed for Columbia-National Corporation, will produce 1,500,000 pounds of hafnium-free Zirconium per year.

2 **Jones & Laughlin Steel Corp., Aliquippa, Pa.** Revolution in coal chemicals! For Jones & Laughlin Steel Corporation Badger engineers came up with a new process application that eliminates the conventional acid-washing step to produce near absolute pure benzene and toluene.

3 **Esso Standard Oil Co., Everett, Mass.** One of three current Powerformer projects being handled by Badger. Unit shown is now producing Golden Esso Extra at Esso's Everett, Massachusetts, refinery. Plant was built completely on "stilts" — piles driven deep into tideland marshes.

4 **Metal Hydrides Inc., Danvers, Mass.** A new plant for the production of Sodium Borohydride, a component of "exotic" fuels. Badger handled the engineering, procurement and construction on this job. Plant was ready in record time even though the process was new and tricky.

5 **Cosden Petroleum Corp., Big Spring, Texas.** Styrene from gasoline! Ultra-fractionation and other pioneering process developments made this "impossible" plant a commercial reality. On stream in February 1957, the plant produced better than plastic-grade styrene right from initial start-up!

6 **Commercial Solvents Corp., Sterlington, La.** More methanol facilities. This unit is one of four built in recent years for Commercial Solvents Corporation. Like all methanol units designed by Badger, no chemical purification step is used, yet the product exceeds all present purity specifications.

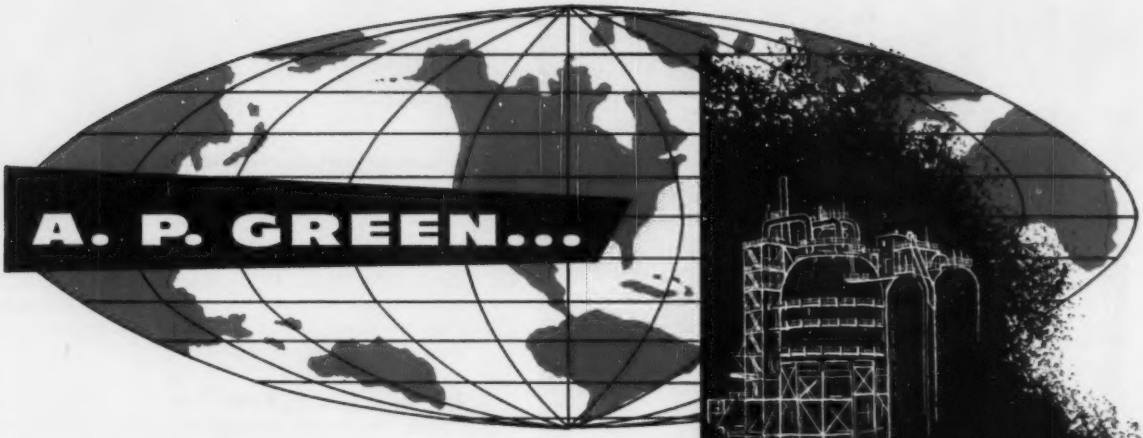
7 **Esso Nederland N. V., Rotterdam, The Netherlands.** Model of two process units similar to those being installed in a complete 100,000 bpsd refinery, now under construction in Rotterdam for Esso Nederland N. V. Badger-Comprimo, owned jointly by Badger and Comprimo N. V., The Netherlands, is prime mechanical, engineering and construction contractor.

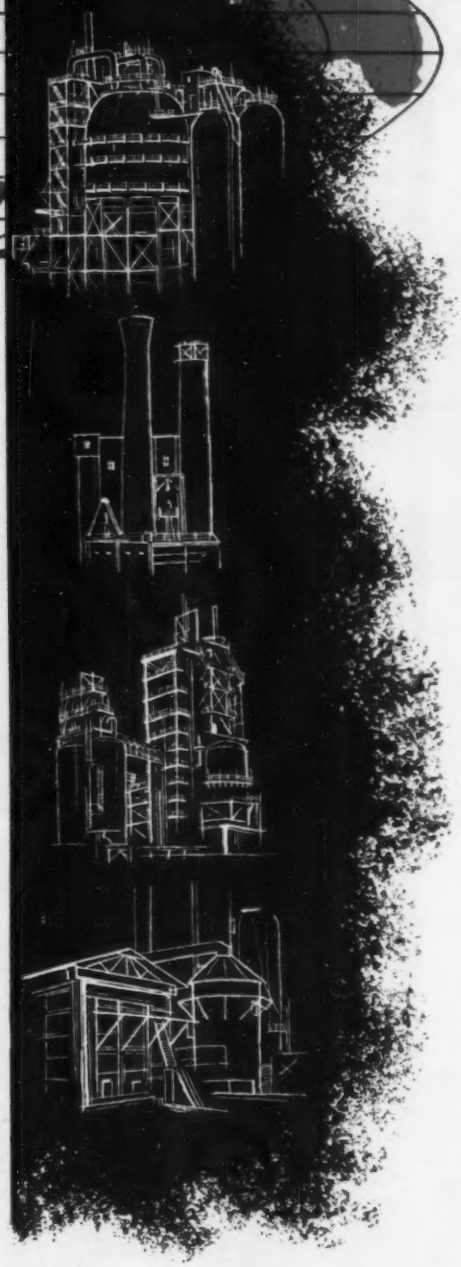
Other current Badger projects

Propane Deasphalting Unit — Anderson-Prichard Oil Corp., Arkansas City, Kansas • MEK Dewaxing-Deoiling Plant — Atlantic Refining Company, Point Breeze, Pa. • HF Alkylation Unit — Champlin Oil & Refining Company, Enid, Okla. • Sulfuric Acid Alkylation Unit — Chinese Petroleum Corporation, Taiwan, Formosa • Continuous Tar Distillation Plant* — Dominion Tar & Chemical Co., Ltd., Hamilton, Ontario • Powerforming Unit** — Esso Standard Refinery S. A., Antwerp, Belgium • Tall Oil Plant -The Glidden Company, Port St. Joe, Fla. • Benzene Udex Unit - Humble Oil & Refining Company, Baytown, Texas • Tall Oil Plant — Monsanto Chemical Company, Nitro, W. Va. • Methanol Plant — Rohm & Haas Company, Houston, Texas • MEK Dewaxing-Deoiling Plant — Sinclair Refining Company, East Chicago, Ind. • Vacuum Distillation Unit — Sinclair Refining Company, East Chicago, Ind. • Paraxylene Plant — Sinclair Refining Company, Houston, Texas • Xylene Udex Unit — Sinclair Refining Company, Houston, Texas.

**Project of Canadian Badger Company Limited*
***Project of Badger-Comprimo N.V., The Netherlands*

THROUGHOUT THE WORLD...





Serves the Petroleum Refining Industry with a Complete Line of High Quality Refractory Products

The petroleum industry, throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

A. P. Green
REFRACTORY
PRODUCTS
SERVING THE WORLD'S INDUSTRIES

A. P. GREEN FIRE BRICK COMPANY
PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas • Jackson, Oak Hill, South Webster, Ohio • Philadelphia, Pa. • Troy, Idaho Pueblo, Colo. • Macon, Ga.

In Canada: A. P. GREEN FIRE BRICK COMPANY, LTD. Toronto 15, Ontario.

In England: LIPTAK, LTD. London, England

Distributors in the Principal Cities of the World

PHOTO COURTESY OF C F BRAUN & CO
ENGINEERS AND CONSTRUCTORS

PACIFIC PUMPS INC was selected to supply practically 100% of TIDEWATER'S centrifugal process pumps for their new DELAWARE FLYING A REFINERY

Pacific's world-wide reputation for engineering pumps with outstanding performance and service records was further evidenced by Tidewater's choice. We are justly proud of this opportunity to put more Pacific pumps to work for Tidewater at Delaware as we have at their Avon, California refinery. It is our feeling that our excellent pump service engineering staff (always available when needed, anywhere, anytime) also influenced their decision. Whatever your pumping requirements—it will pay you to consult Pacific.

PACIFIC

PACIFIC PUMPS INC.

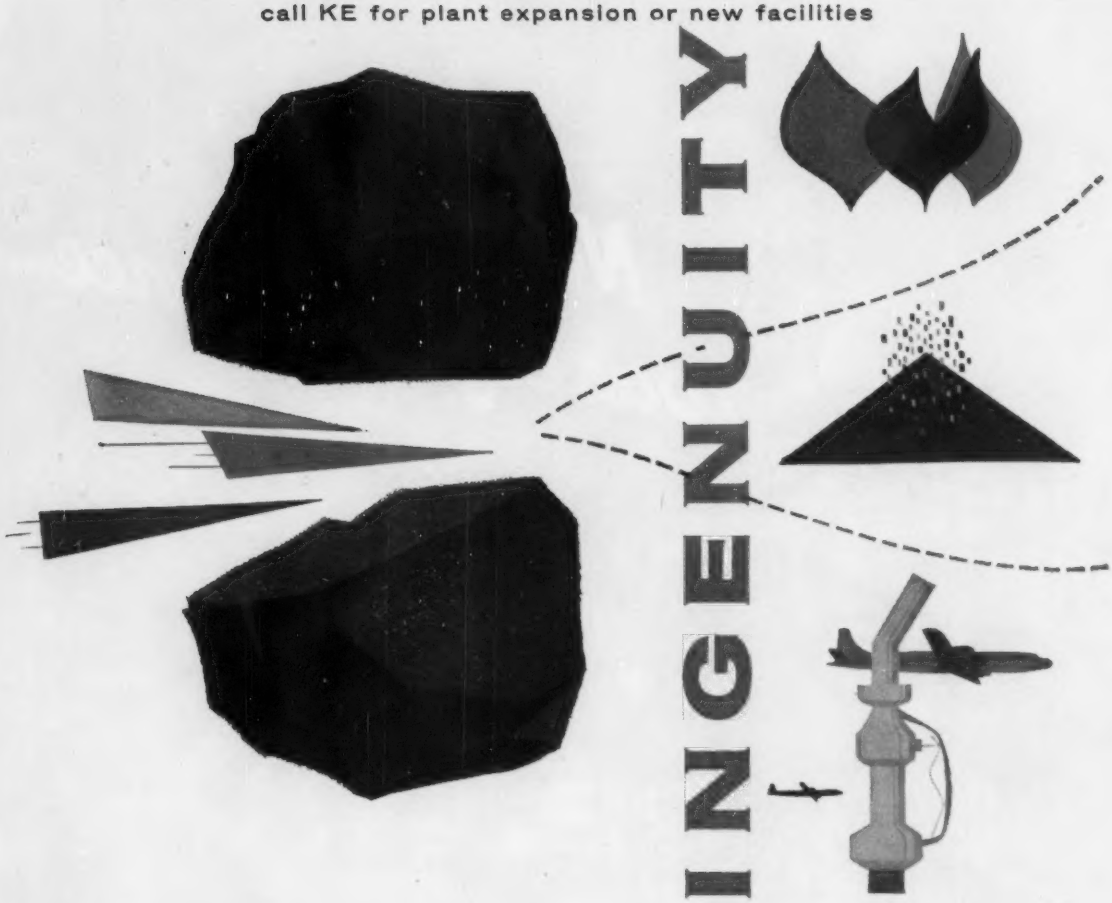
HUNTINGTON PARK, CALIFORNIA

Offices in all Principal Cities

CP-17

For more data on advertised products, use Readers' Service Cards, last page.

call KE for plant expansion or new facilities



has made KE a major engineer-contractor serving Minerals and Petroleum

Nation's pioneer major commercial Gilsonite refinery near Grand Junction, Colorado... Another example of KE ingenuity.

Ingenuity at work—at American Gilsonite, Kaiser Engineers designed and built an enclosed, controlled-atmosphere calciner with associated power and plant equipment making possible 100% utilization of raw Gilsonite. First major all-commercial Gilsonite refinery built, the new plant produces 99.50% pure coke, extreme purity gasoline, and uses gaseous residue to power the entire facility.

From economic analysis through start-up, KE builds ferrous, non-ferrous, industrial minerals and petroleum processing plants; brings valued experience to every phase from mining and beneficiation to transportation and materials handling.

Let KE ingenuity save time and money for you. With your first thought of new facilities or expansion, call KE.

KAISER ENGINEERS engineers—contractors
Contracting since 1914

4385

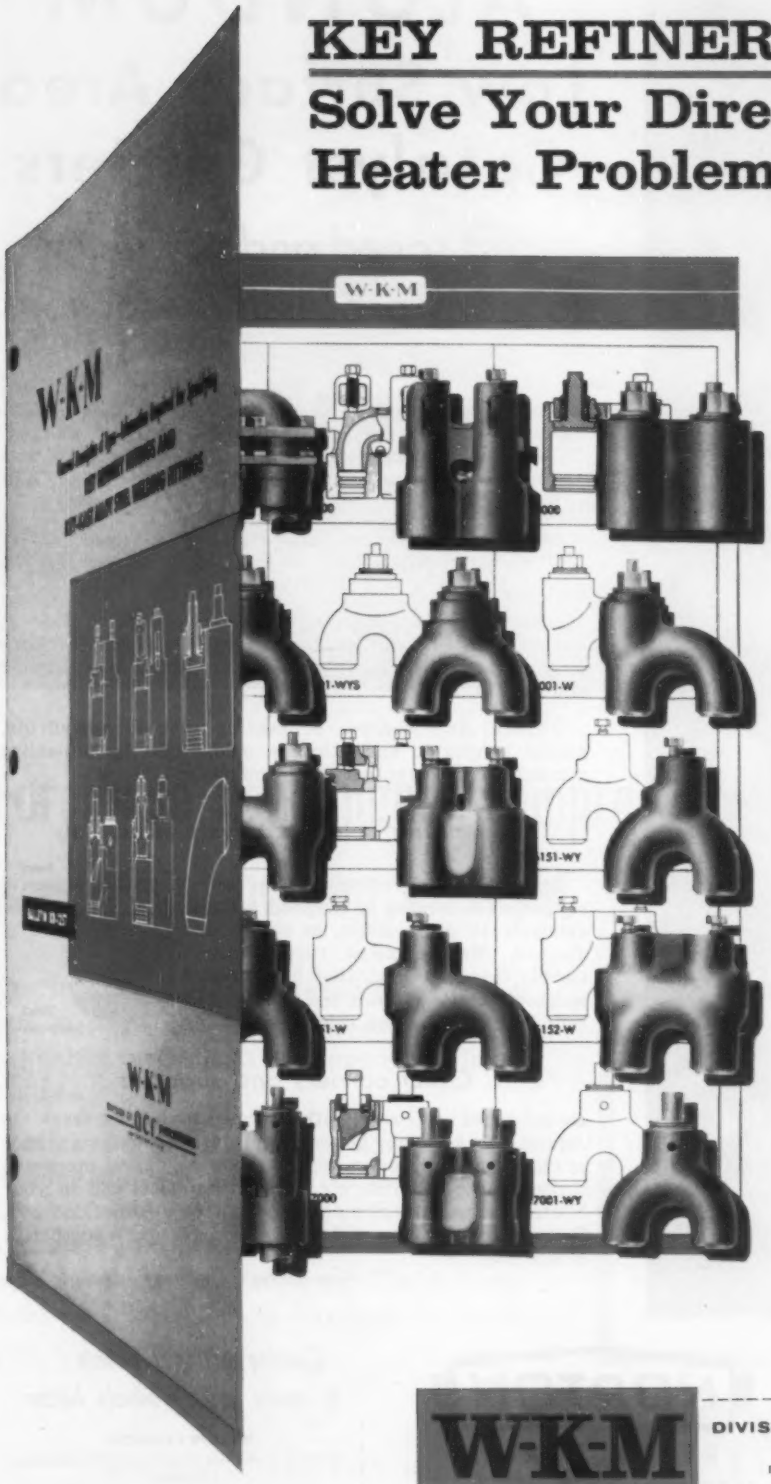
Division of Henry J. Kaiser Company • Oakland 12, California • New York, Pittsburgh, Washington, D.C., Buenos Aires, Calcutta, Dusseldorf, Montreal, Rio de Janeiro, Sydney, Tokyo

For more data on advertised products, use Readers' Service Cards, last page.

W-K-M's

KEY REFINERY FITTINGS

Solve Your Direct-Fired Heater Problems



W-K-M's continuous research, broad experience and active participation in fitting design have been combined to anticipate your needs . . . W-K-M's engineers have solved most of your problems before they exist.

W-K-M's Bulletin KR-1257 details types of Key Refinery Fittings and gives information that will assist you in preparing a bill of materials for new construction, in ordering for inventory. Write for it . . . or call a Key Products engineer to go over your plans and assist you in outlining your requirements.

W-K-M's engineering and manufacturing assure longer life, lower costs for high-pressure, high-temperature piping systems.

W-K-M's Engineering in the field

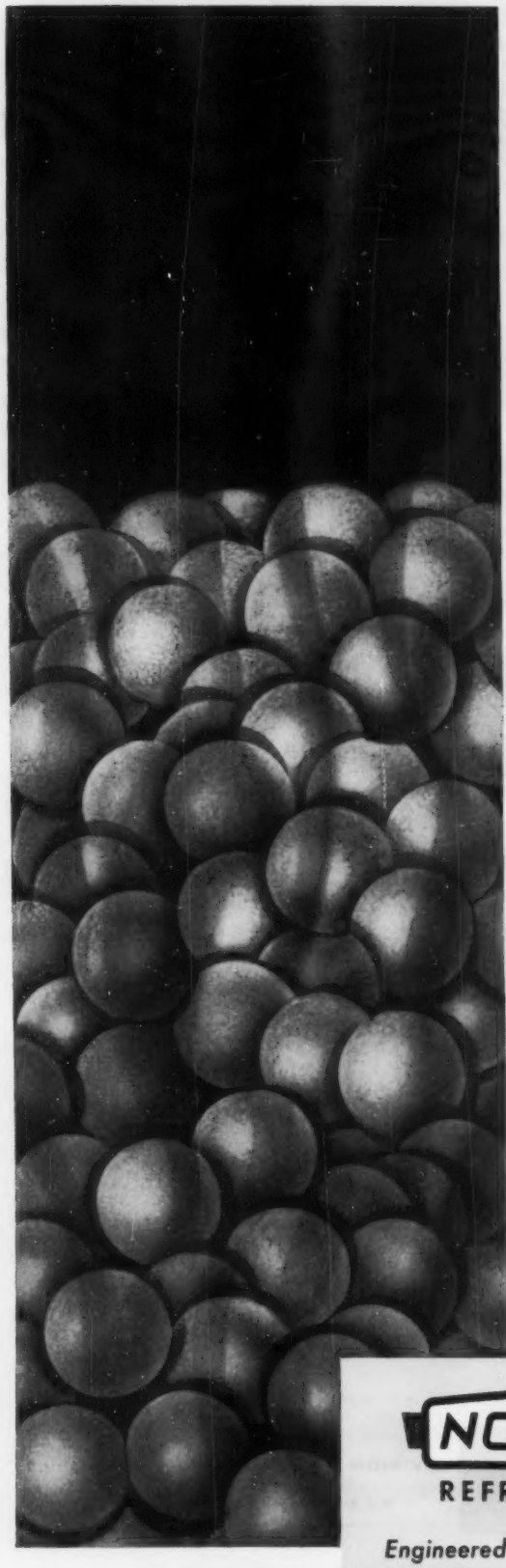
A highly trained Key Products field service engineer is at the other end of your telephone. His broad experience in the solution of fitting design problems for your direct-fired furnaces is yours for the asking.

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5802

For more data on advertised products, use Readers' Service Cards, last page.



ALUNDUM*
Low Surface Area Catalyst Carriers
...add speed and efficiency to many processing reactions

Crystalline in nature, Norton ALUNDUM catalyst carriers have excellent mechanical, thermal and chemical stability. The most widely used type has low surface areas of less than $1 m^2/gram$, combined with high alumina content of 77% to 92%.

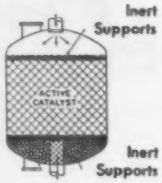
Shapes and Sizes: low surface area type; spheres 3/16" to 1½" diameter; pellets ⅛" x ⅛" to ½" x ½"; rings ⅛" x ⅜" x ⅜" O.D. to 1" x 1½" x 1½" O.D.

Other Physical Properties: apparent porosity 10-50%; water absorption 3-25%; bulk density 1.90-3.15 gr/cc; volume bulk density 65-80 lbs/ft^3; crystal structure alpha alumina and mullite.

Typical Applications: processing phthalic anhydride, maleic anhydride and ethylene oxide; also in protective atmospheres and synthetic gas generation.

Suspending active catalysts effectively

In fixed bed convertors, Norton inert supports are located to suspend active catalysts at given levels, as shown in diagram. Made of dense, rugged, electrically fused materials they have great resistance to breakdown and no chemically reactive effect on the processing.



Other carriers and supports

are produced by Norton with intermediate surface areas. On request, any type may be prepared from other materials, such as CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, zirconium oxide, silica, etc. For further facts call in your Norton Refractories Engineer, or write to NORTON COMPANY, Refractories Division 468 New Bond Street, Worcester 6, Massachusetts.

*Trademarks Reg. U. S. Pat. Office and Foreign Countries.

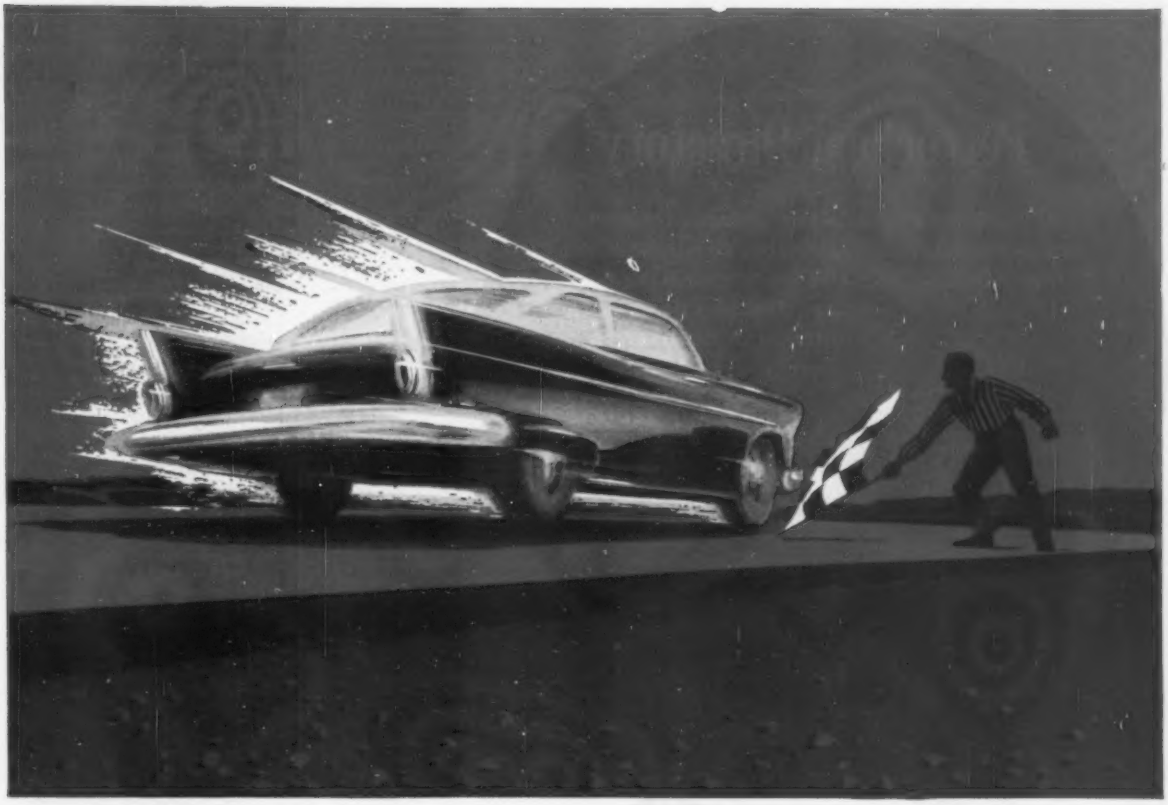
NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products...
to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels • Grinding Machines
Refractories

BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones
Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.



For those new, higher compression engines...

a new Catforming catalyst

The trend to higher compression engines is here to stay. And wide-awake refiners have to produce fuels to suit these up-to-the-minute engines.

Atlantic is proud to offer an advanced Catforming catalyst designed to economically produce higher octane gasolines . . . *and it can be utilized in your present equipment.* For more information, write, wire or call The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

Higher gasoline octanes through Pentafining

You can convert the low-quality n-paraffins (C_5, C_6, C_7) in your gasoline pool to high octanes! Pentafining, the process developed by The Atlantic Refining Company, makes it possible. For full particulars, write today to The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

It's the CATALYST that counts

ATLANTIC

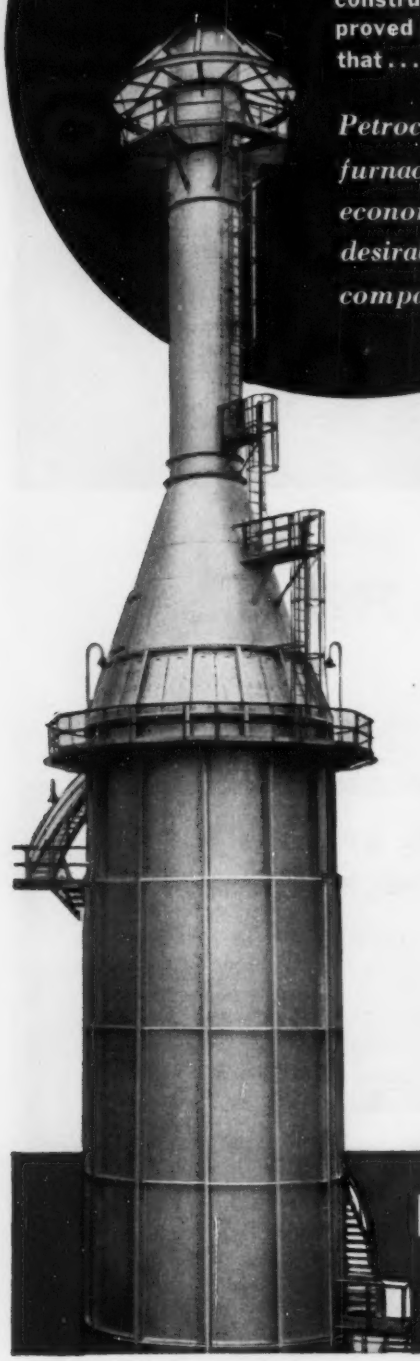
For more data on advertised products, use Readers' Service Cards, last page.

the

Petrochem Directory

of Isoflow furnace users includes refiners and petrochemical processors throughout the free world. They and the engineering and construction firms have proved to themselves that . . .

Petrochem Isoflow furnaces are most economically desirable by any comparison.



* Illustrates repeat orders

Abasand Oils Ltd.
Abercrombie, J. S.
Acadia Corp.
"Albatros", Societe Anonyme Belge Pour Le Raffinage De Petrole
*Allied Chemical & Dye Corp.
*American Bitumuls & Asphalt Co.
*American Cyanamid Co.
American Gilsonite Co.
*American Oil Co.
*American Republics Corp.
Anchor Gasoline Corp.
*Anderson-Prichard Oil Corp.
Anglo-American Exploration, Ltd.
*"Aquila", Societa Per Azioni Tecnico-Industriale
*Arabian American Oil Co.
Arkansas Fuel Oil Corp.
*Arkansas Louisiana Gas Co.
Asahi Chemical Industries, Ltd.
*Ashland Oil and Refining Co.
Asia Oil Co.
*Asiatic Petroleum Corp.
Atlanta Gas Light Co.
*The Atlantic Refining Co.
Atlantic Seaboard Corp.
Atlas Powder Co.
*Atlas Processing Co.
Attock Oil Co., Ltd.
*Aurora Gasoline Co.
*Azienda Nazionale Idrogenazione Combustibili

*The Bahrain Petroleum Co., Ltd.
Barnsdall Oil Co.
*Bay Refining Corp.
Berry Asphalt Company of Arkansas
*Bitumen and Oil Ref. (Australia) Ltd.
The Blanton Co.
Boake-Roberts
Bowie Gasoline Co.
Brazos River Gas Company
*British American Oil Co., Ltd.
*British Petroleum Chemicals, Ltd.
*The British Petroleum Co., Ltd.

*Cabot Carbon Co.
California Asphalt Corp.
*The California Co.
California Refining Co.
*California Texas Oil Co., Ltd.
Calumet Refining Co.
Canadian Chemical Co., Ltd.
Canadian Industries, Ltd.
*Canadian Oil Refineries, Ltd.
Canadian Titanium Pigments
Canton Refining Co.
*Carbide & Carbon Chemical Corp.
Phillip Carey Mfg. Co.
*Caribbean Petroleum Co.
Caribbean Refining Co.
*The Carter Oil Co.
Carthage Co.
Cathage Hydrocol, Inc.
*Celanese Corporation of America
Champlin Oil and Refining Company
Chemicals & Solvents Co.
Chinese Petroleum Corp.
Cit-Con Oil Corp.
*Cities Service Oil Co.
Clairborne Gasoline Co.
*Clark Oil & Refining Corp.
Cliffs-Dow Chemical Co.
Col-Tex Refining Co.
*Colorado Interstate Gas Co.
*Columbian Carbon Co.
*Columbian-Southern Chemical Corp.
*Commercial Solvents Corp.
*Compagnie Fraricaise de Raffinage
Compagne Industr. de Traveaux
Compagnie Cons. de Petroleo
Compagnie Tecnica Industrie Petr.
*Continental Oil Co.
*Conway Oil
*Cooperative Refinery Ass'n
Coronado Oil Co.
*Cosden Petroleum Corp.
Coastal Refining Co.
*Creole Petroleum Corp.
Compania Ferrocarribora de Petr.

*Davison Chemical Corp.
Deutsche Erdöl Atkiengesellschaft
*Deep Rock Oil Corp.
*Delhi-Taylor Oil Corp.
*The Derby Oil Co.
*Dow Chemical Company
*duPont de Nemours & Co., E. I.

*Eastern States Petr. & Chem. Corp.
The El Dorado Refining Co.
*El Paso Natural Gas Products Co.
*Elk Refining Co.
Empire Petroleum Co.
Empire State Oil Co.
Equitable Gas Co.
Esslinger-Misch Co.
*Esso Eng. & Research
Esso Petroleum Co., Ltd.
*Esso Standard Oil Co.
Etablissement Kuhlmann
*Ethyl Corp.

*Farmers Union Central Exch. Inc.
The Firestone Tire & Rubber Co.
Fletcher Oil Co.
Foster Grant Co., Inc.
Francitas Gas Co.
Freeport Sulphur Co.
Frontier Natural Gasoline Co.
*Frontier Refining Co.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

*Gasoline Products Corp.
General Aniline & Film Corp.
*General Petroleum Corp.
Goliad Corp.
*Great Northern Oil Co.
Gulf Kuwait Co.
*Gulf Oil Corp.
Gulf States Recycling

*Hancock Oil Co.
U. S. Army Hq. Air Material Comm.
Hi-Way Refining, Ltd.
Honolulu Oil Corp.
Hope Natural Gas Co.
Houillens de Bassin de Lorraine
*Humble Oil & Refining Co.
*Hunt Oil Co.
*Husky Oil Co.
Hydrocarbon Chemical Co.

*Idemitsu Kosan Co., Ltd.
*Imperial Oil, Ltd.
Indiana Farm Bur. Co-op. Ass'n., Inc.
*Industries Quimicas Eletro Cloro
*Ingram Oil & Refining Co.
International Refineries, Inc.

Jarvis Refinery Co.
Jesco Lubricants Co.
*Johns-Mansville Products Corp.
A. Johnson & Company
*Jones & Laughlin Steel Co.

Kendall Refining Co.
Koa Oil Co., Ltd.
*Koppers Co., Inc.
Kuwait Oil Co., Ltd.

Lake Superior Refining Co.
La Porte Titanium Ltd.
*Leonard Refineries, Inc.
*Lion Oil Co.
*Lobitos Oil Fields, Ltd.
Lone Star Sulphur Corp.
Louisville Refining Co., Inc.
Lubrizol Corporation, The

Maersk Refinery Co.
*Magnolia Petroleum Co.
Maljamar Cooperative
Repressuring Agreement
Matagorda Corp.
McCarthy Oil & Gas Corp.
*McColl-Frontenac Oil Co., Ltd.
*McMurrey Refining Co.
McNutt Oil & Refining Co., Inc.
Mene Grande Oil Co.
Michigan Consolidated Gas Co.
Michigan Wisconsin Pipe Line Co.
*Mid-West Refineries, Inc.
*Midland Cooperatives, Inc.
Mississippi River Fuel Corp.
Mississippi Chemical Corp.
*Mitsubishi Oil Co., Ltd.
*Mitsui Petrochemical Industries
Mohawk Petroleum Corp.
*Monsanto Chemical Co.
*Montana Dakota Utilities Co.

*Naph-Sol Refining Co.
National Cooperative Ref. Ass'n.
*National Lead Co.
National Refining Co.
Naugatuck Chemical Co.
*Neches Butane Products Co.
Neville Chemical Co.
*New Mexico Asphalt & Refining Co.
New York State Natural Gas Corp.
*Nippon Petroleum Refining Co., Ltd.
Northern Utilities Co.

Odessa Natural Gasoline Co.
*The Ohio Oil Co.
Old Colony Tar Co.
Old Dutch Refining Co.
*Olin-Mathieson Chemical Corp.
Onyx Refining Co.
Oyster Shell Products Corp.

Pacific Refiners Ltd.
*Pan American Petroleum Corp.
Pan American Refining Corp.
Pan American Southern
Pana Refining Co.
Panhandle Eastern Pipe Line Co.
The Parade Gasoline Co.
Paraffine Oil Co.
Pecos Petr. Co.
*Pennsylvania Ind. Chemicals Corp.
Petco Corp.
Petro-Tex Chemical Corp.
Petrocarbon Chemicals, Inc.
Petrochemicals Ltd.
Petrol Refining Co.
*Petroleo Brasileiro S. A.
*Petroleos Mexicanos (Pemex)
Petroleum Chemicals, Inc.
*Petrolite Corp.
*Phillips Chemical Co.
*Phillips Petroleum Co.
Phillips Pipe Line Co.
Pittsburgh Consolidated Chemical
Plains Nat'l Gas Co.
*Plymouth Oil Co.
*Polymer Corporation, Ltd.
Pontiac Refining Corp.
*Portland Gas & Coke Co.
Premier Oil Refining Co. of Texas
Publicker Comm. Alcohol Co.
*The Pure Oil Company
Queensland Refineries

R. J. Oil & Refining Co., Inc.
*Raffineries Francaises de Petrole
de L'Atlantique
Raffinerie Belge de Petrole S. A.
Rafinería E. Exploreco de Petroleo
Rederiaktiebolaget Nordstjernan
*Regent Refining Ltd.
Regie Autonome des Petroles
Rhone-Poulenc
*Richardson Refining Co.
*Richardson and Bass
*Richfield Oil Corp.
*Richmond Exploration Co.
*Rock Island Refining Co.
*Royalite Hi-Way, Ltd.
*Ruberoid Co.

*Salt Lake Refining Co.
*Shamrock Oil & Gas Corp., The
*Shell Oil Company of Canada, Ltd.
*Shell Caribbean Petroleum Co.
*Shell Chemical Corp.
*Shell Oil Co.
*Shell Refining & Marketing
Sidon Refining
Signal Oil & Gas Co.
Simon Carves
*Sinclair-Prairie Oil Co.
*Sinclair Refining Co.
Siry-Chamon Co.
*Skelly Oil Co.
*Societa Edison
Societe de Belge de L'Azote
Societe Cherifienne des Petroles
*Societe Francaise des Petroles BP
*Societe Industr. Belge des Petr., S. A.
*Societe Naphtachimie
*Societe Nationale
des Petroles d'Aquitaine
*Socony Mobil Oil Co., Inc.
*Solvay & Co.
Southern Cotton Oil Co.
Southern Natural Gas Co.
*Southport Petroleum Co.
*Southwestern Oil & Refining Co.
*Spora-Kopparberg
Standard Oil Co. of Argentine
Standard Oil Co. of Brit. Col., Ltd.
*Standard Oil Company of California
*Standard Oil Company (Indiana)
*The Standard Oil Company (Ohio)
*Standard Oil Company of Texas
*Standard-Vacuum Oil Co.
Stanic Industr. Petrolifera, S.p.A.

*Stanolind Oil Co.
Stauffer Chemical Co.
Sterling Oil Co.
Stoll Ref. Co.
*Sun Oil Co.
*Sunray Mid-Continent Oil Co.
*Sunset International Petroleum Corp.
Swedish Shale Oil Co.

Taiwan Fertilizer Co., Ltd.
*Takamine Overseas, Inc.
Tankage & Transport, S. A.
Tar Distilling, Inc.
Taylor-Mayfair, Inc.
Tecnica Idrocarburi e Derivati
*Tennessee Gas Transmission Co.
Terminal Refining Co.
*Texas Butadiene & Chemical Corp.
*The Texas Co.
Texas Eastman Co.
*Texas Gas Corp.
*Texas Gulf Producing Co.
Texas Natural Gasoline Corp.
Thermatomic Carbon Co.
*Tidewater Oil Co.
*Transcontinental Gas Pipe Line Corp.
*Trinidad Leaseholds, Ltd.
Trinity Gas Corp.

*United Gas Pipe Line Co.
United Fuel Gas Corp.
*Union Oil of California
Union Rheinische Braunkohlen
Kraftstoff A. G.
U. S. Rubber Co.
U. S. Steel Corp.
Utah Oil Refining Co.

Valley Refining Co.
N. P. Van Valkenburgh
Venezuela Gulf Refining Co.
*The Vickers Petroleum Co., Inc.

*Warren Petroleum Corp.
Wasatch Oil Ref. Co.
West Branch Refineries, Inc.
Westlake Gasoline Corp.
Williams, C. K.
Wilshire Oil Co., Inc.
Woodlawn Processing Co.
*Wyco Pipe Line Co.

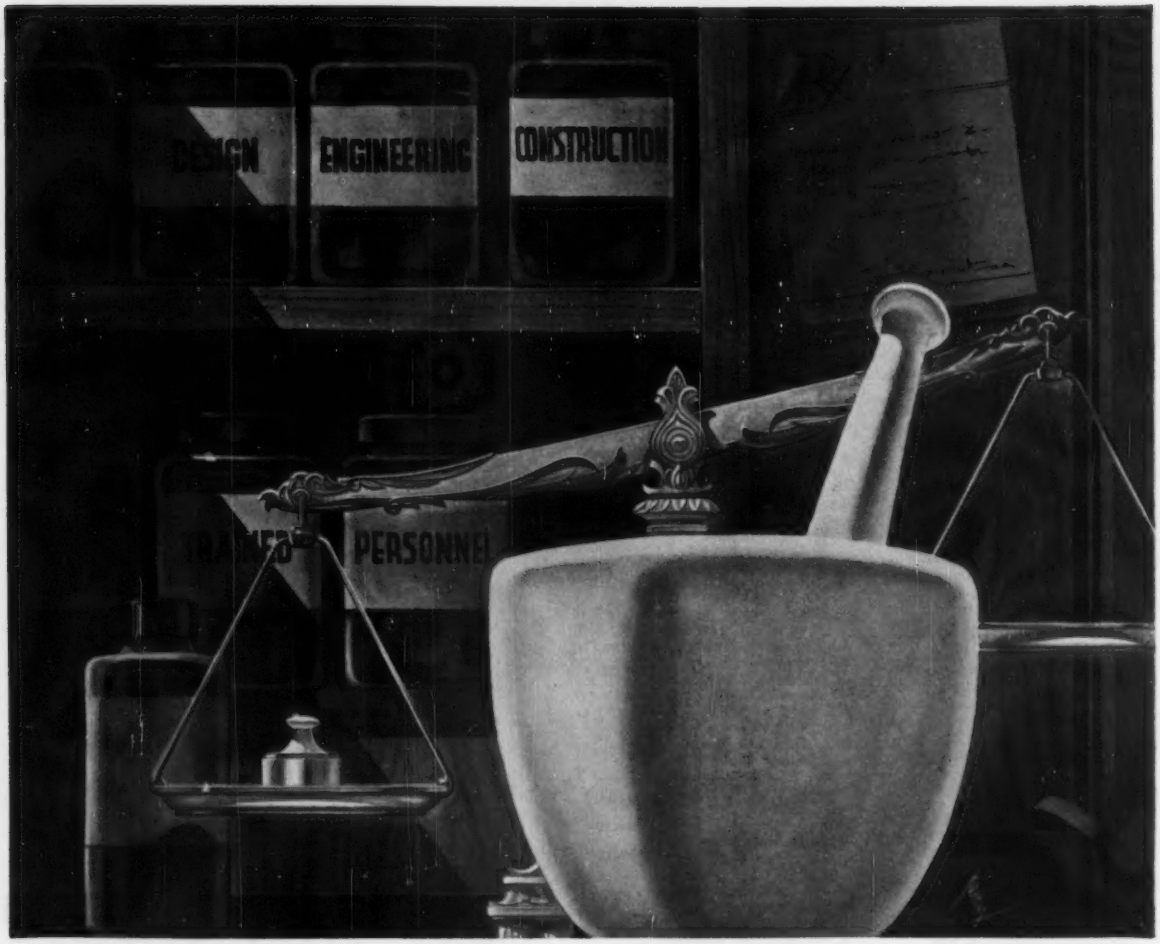
*Yacimientos Petrol. Fiscales (Gov't)

CONTRACTORS & ENGINEERS

Austin Co.
Badger Manufacturing Co.
Bechtel Corp.
Bechtel-Price-Callahan
Bechtel McCone
Blaw-Knox Co.
H. A. Brassert
C. F. Braun & Co.
Brown & Root, Inc.
Canadian Bechtel, Ltd.
Canadian Kellogg
Catalytic Construction Co.
Chemical Constr. Corp.
Delta Engineering Corp.
Dresser Engineering Co.
Ehrhart & Assoc., Inc.
The H. K. Ferguson Co.
Fish Engineering Co.
The Fluor Corp., Ltd.
Ford, Bacon & Davis, Inc.
Foster Wheeler Corp.
Gasoline Plant Constr. Co.
J. B. Gill Co.
The Girdler Co.
Graver Constr. Co., Inc.
L. S. Gregory & Co.
Houston Oil Fields Mat'l Co.
Hudson Engineering Co.
The Humko Co.
Hydrocarbon Research, Inc.
Jones & Laughlin Steel Corp.
The M. W. Kellogg Co.
Koch Engineering Co.
Koppers Co., Inc.
Litwin Engineering Co.
The Lummus Co.
Arthur G. McKee & Co.
O. L. Olsen Co.
The Ralph M. Parsons Co.
Petroleum Construction Co.
Petroleum Engineering Co.
Pittsburgh Des Moines Steel Corp.
Preston Construction Co.
Pritchard Co.
Process Engineers
Procon, Inc.
The Refinery Engineering Co.
Refinery Maintenance Co.
Scientific Design Co., Inc.
Southwestern Engineering Co.
Stearns-Rogers Mfg. Co.
Stone & Webster Eng. Corp.
Stratford Engineering Corp.
Tears Engineering Co.
United Engineers & Constr., Inc.
Universal Matthey Products, Ltd.
Universal Oil Products Co.
Vitro Corp.
Walco Engineering & Constr. Co.
Del F. Webb
The J. G. White Eng. Corp.

REPRESENTATIVES:
Rawson & Co., Houston & Baton Rouge • Wm. H. Mason Co., Tulsa • Lester Oberholtz, Los Angeles • Faville-Levally, Chicago
D. C. Foster, Pittsburgh • Turbex, Philadelphia • Flagg, Brackett & Durgin, Boston • G. W. Wallace & Co., Denver & Salt Lake City
International Licensees and Representatives: SETEA—S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentine •
Industrial Proveedora, Caracas, Venezuela • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge Heurtey, Liege, Belgique •
Petrochem G.M.B.H., Dortmund, Germany • Heurtey Italiana S.P.A., Milan, Italy • Birwelco Ltd., Birmingham, England

For more data on advertised products, use Readers' Service Cards, last page.



FAST REFINERY CONSTRUCTION
demands the RIGHT combination . . . .

The ingredients are well known; but the proper proportions and blending are what make the difference. To meet today's requirements for higher-octane fuels and a greater range of petrochemicals, you not only must have the assurance of fast construction, but the knowledge your plant will enable you to attain and maintain a competitive position. Treco gives you that assurance.

Treco would like to talk with you prior to the planning stage. This could save you both time and money later.

....talk with the TRECO man.....

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

FARMINGTON NEW YORK TULSA TORONTO

For more data on advertised products, use Readers' Service Cards, last page.

A "Bump and Grind" Performance

. . . you can do without!

Even a hard-boiled chemical engineer can get a kick out of a good "bump and grind" performance on the stage. But when it happens in a tower it's a headache to all concerned.

Movement in a packed bed can be brought about by a number of things: a pulsating gas stream, vibration of the tower, or the tendency to operate a tower as close to the flooding limit as possible. Whatever the cause, unless some means is provided to confine the packed bed, the continuous "bump and grind" will destroy the packing.

U. S. Stoneware offers a simple solution to the problem: a floating "hold down" plate which rests on top of the packed bed and whose weight holds the packing in place. U. S. Stoneware hold down plates* are made to fit any size tower in a variety of weights ranging from 10 lbs. to 50 lbs. per square foot. They are available in ceramic, in mild steel, stainless steel or copper.

*Patent applied for

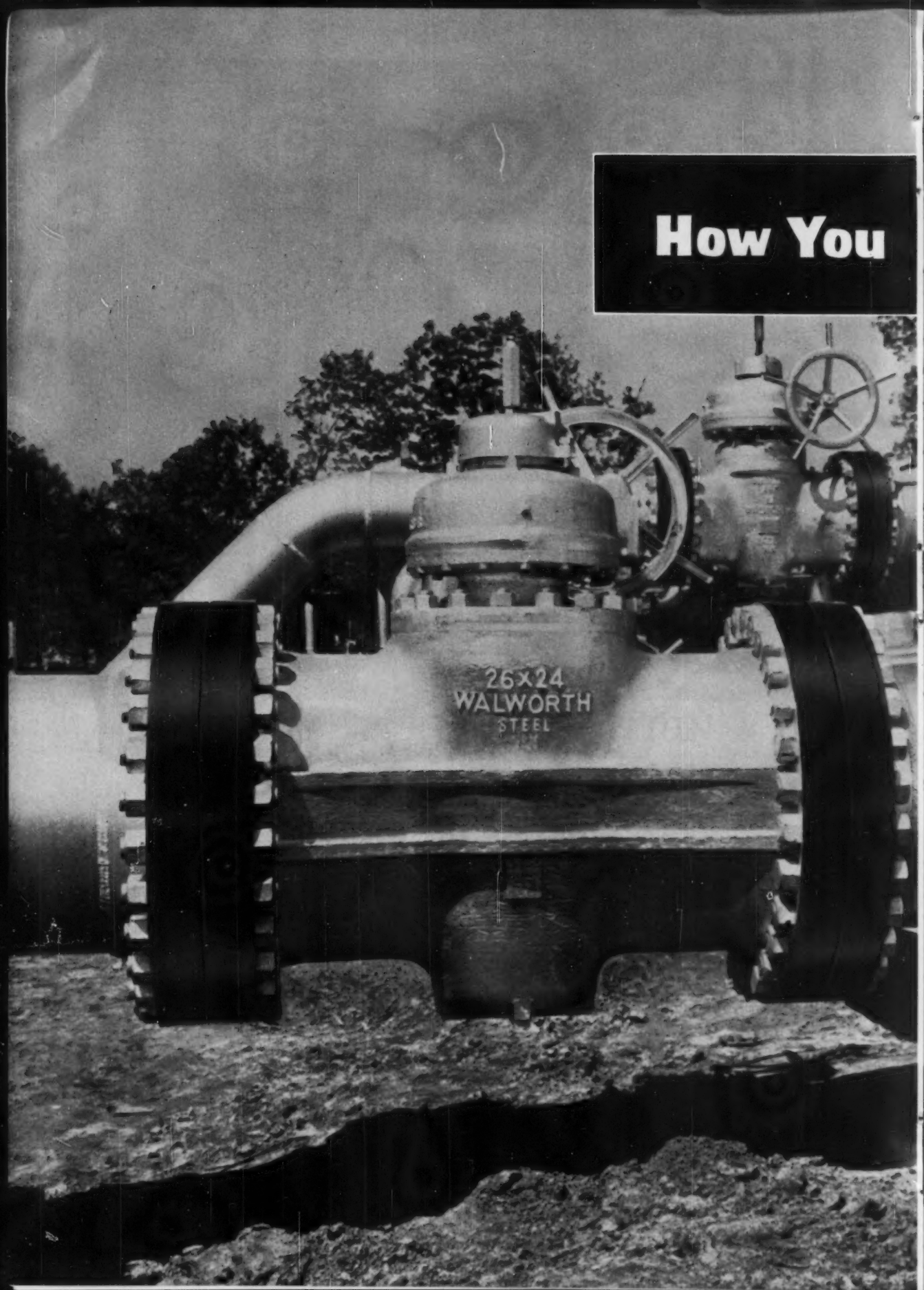
For full details on U. S. Stoneware's "hold down" plates, write for Bulletin HDP-56.

U. S. STONEWARE

AKRON 9, OHIO

215-F

For more data on advertised products, use Readers' Service Cards, last page.


How You
26X24
WALWORTH
STEEL

Profit With Better Plug Valves

Walworth Lubricated Plug Valves, available through Jones & Laughlin Supply Division, will give you better performance with these plus features.

All **Walworth Lubricated Plug Valves** are hydrostatically tested at every position from wide open to fully closed.

Positive open and closed stops and position indicators eliminate the guesswork in your valve operations.

Designed with the adjustments on top, **Walworth Lubricated Plug Valves** are more accessible.

The direct port opening of these valves eliminates flow restrictions.

You can have **Walworth Lubricated Plug Valves** in sizes from ¼" to 30". Walworth technical specialists will gladly assist in your valve engineering.

Call your local Jones & Laughlin Supply Division store or office for complete information on better plug valves.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

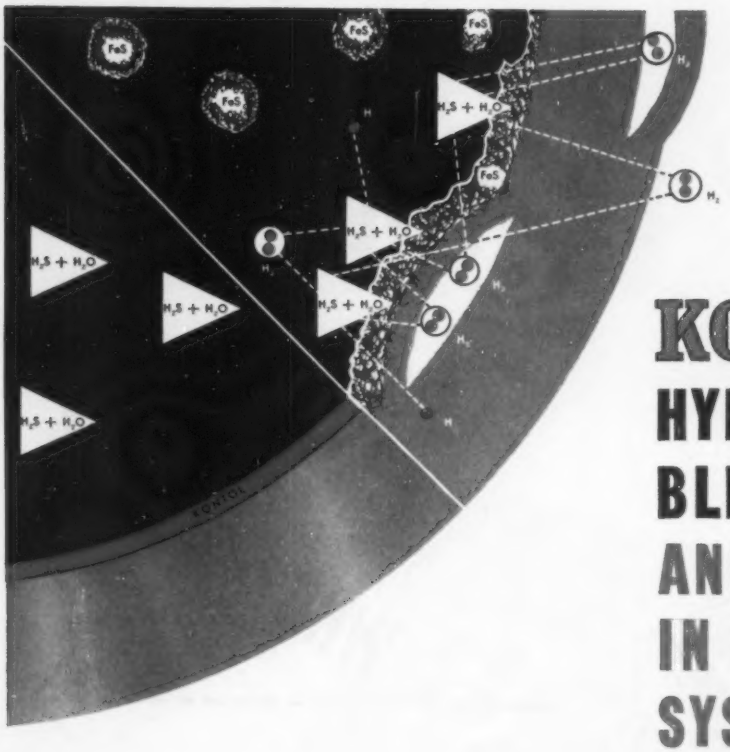
When you plan
process plant facilities,
take advantage of Girdler's
proven experience as
engineer-constructors

GIRDLER HAS SERVED

Allied Chemical & Dye Corp.
Anderson, Clayton & Co.
Apache Powder Co.
Armour & Co.
The Atlantic Refining Co.
The Borden Co.
Canadian Chemicals Co.
Canadian Industries Ltd.
Celanese Corp. of America
Chemstrand Corp.
Cities Service Oil Co.
Colgate-Palmolive Co.
Consumers Farm Chemicals Assn.
Delta Refining Co.
Dow Chemical Co.
E. I. duPont de Nemours & Co.
Eastman Kodak Co.
Thomas A. Edison, Inc.
Esso Standard Oil Co.
Freeport Sulphur Co.
General Mills, Inc.
B. F. Goodrich Chemical Co.
Goodrich-Gulf Chemicals, Inc.
Hercules Powder Co., Inc.
Lever Bros. Co.
Lion Oil Co.
Metal Hydrides Co.
Midwest Carbide Corp.
Mississippi Chemical Corp.
Monsanto Chemical Co.
National Distillers Products Corp.
North American Cyanamid Ltd.
Pennsylvania Salt Manufacturing Co.
Phelps-Dodge Corp.
Philadelphia Electric Co.
Phillips Petroleum Co.
The Procter & Gamble Co.
Pure Carbonic, Inc.
Rohm & Haas Co.
Southern Cotton Oil Co.
Southern Nitrogen Co., Inc.
Standard Oil Co. of Calif.
Standard Oil Co. (Indiana)
Standard Oil Co. of Louisiana
Sun Oil Co.
Swift & Co.
Tennessee Eastman Co.
Texas Eastman Co.
Union Oil Co. of California
Wilson & Co., Inc.

What we can do for YOU is described in new brochure G-306.
Write for your copy today.

GIRDLER
CONSTRUCTION
DIVISION
CHEMETRON CORPORATION
Louisville 1, Kentucky
Sales Offices: New York, N. Y.; San Francisco, Calif.
CHEMETRON
TRADE MARK



KONTOL STOPS HYDROGEN BLISTERING AND CORROSION IN FRACTIONATING SYSTEM

Before protection with Kontol, a mid-continent refinery's fractionating system was plagued by widespread corrosion and hydrogen blistering. Hydrogen probe activity registered a 25 psi pressure build-up in an 8-hour period. Kontol was injected into the overhead of the main fractionator at the rate of 9 ppm. This treatment was continued over an 18 month period. Hydrogen probe activity was practically nil soon after Kontol treatment was started. Visual inspection indicated no further appreciable damage to equipment, with all condensers and exchangers very clean and no leaking of overhead condensers developing between shutdowns.

METAL ANALYSES since KONTOL treatment

AREA	% reduction in iron content	% reduction in copper loss
Debutanizer feed drum water	93	70
Debutanizer overhead accumulator water	85	46
Main fractionator overhead accumulator water	90	67

WRITE today for the full report on this and other refineries who are using KONTOL corrosion preventives.

TRETOLITE COMPANY

DIVISIONS OF PETROLITE CORPORATION

369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

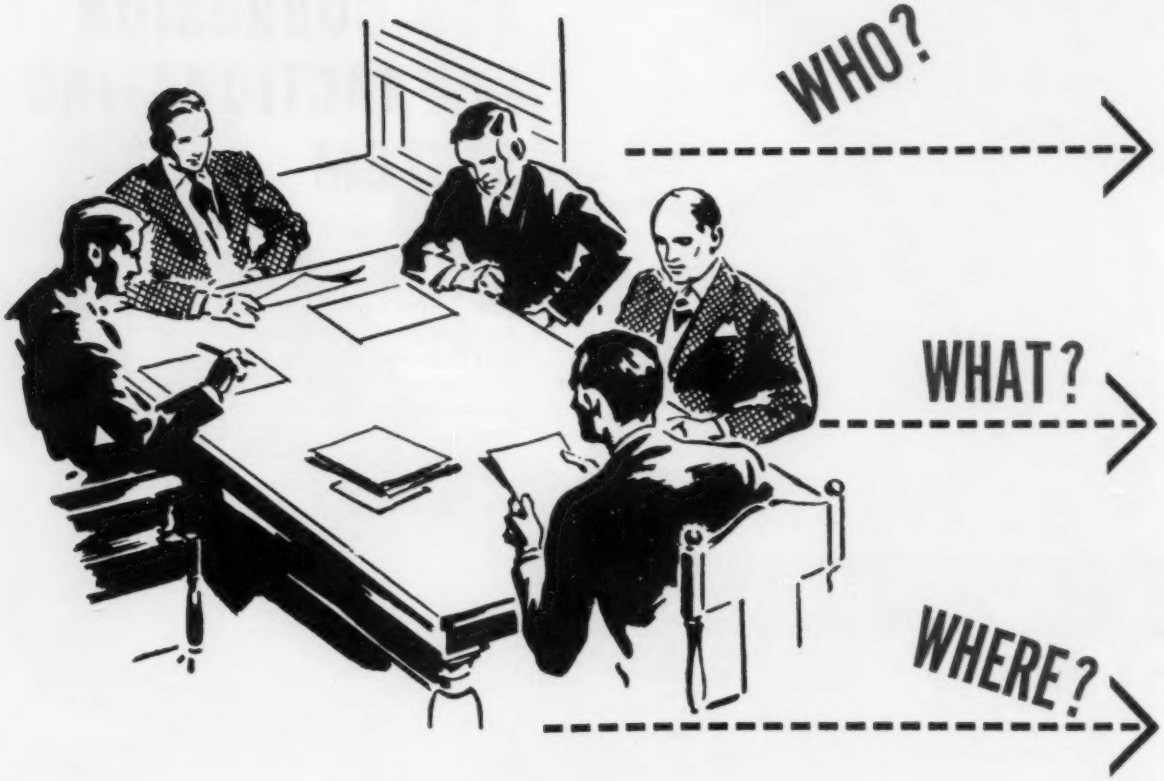
Chemicals and Services for the Petroleum Industry

DESALTING • CORROSION INHIBITING
DEMULSIFICATION • SCALE PREVENTION • WATER DE-OILING
METAL DEACTIVATION • ADDITIVES

KR-58-1

For more data on advertised products, use Readers' Service Cards, last page.

With Men

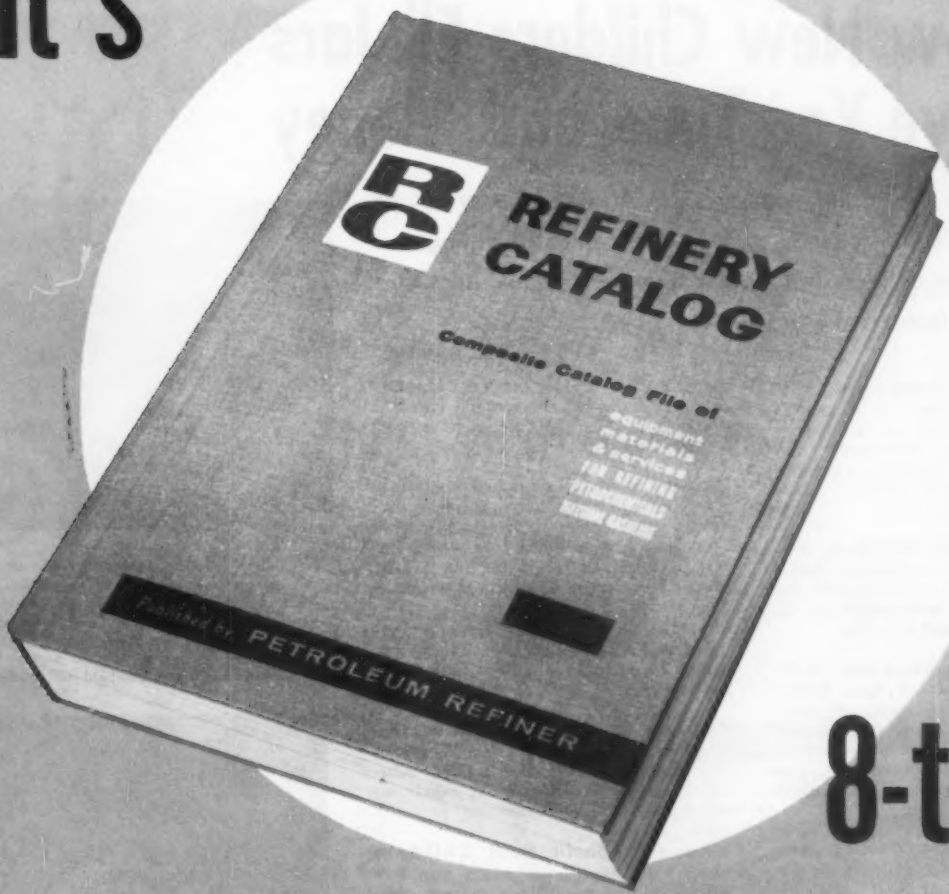


REFINERY CATALOG

Published by Petroleum Refiner

Who Buy And Specify

It's

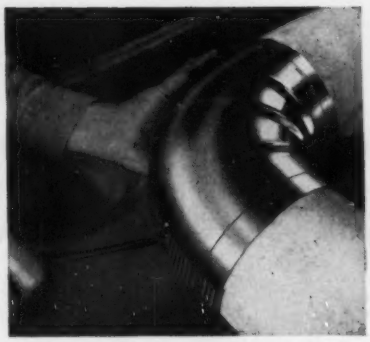


8-to-1

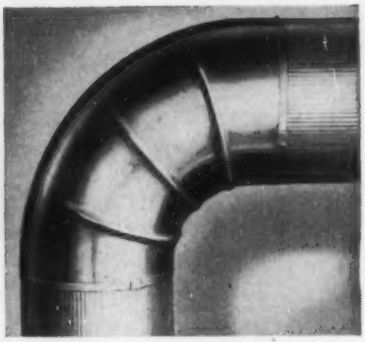
Look to REFINERY CATALOG for quick answers to your procurement problems in the refining, natural gasoline and petrochemical industry. It's indexed and cross-referenced to save time and eliminate error in planning, buying and specifying for this fast-moving market. That's why buyers and specifiers express a preference of 8-to-1 for REFINERY CATALOG over individual product catalogs.

The next time *you* sit down to figure a job, look *first* in REFINERY CATALOG. You'll find it contributes to greater speed and accuracy.

9:00 A.M. Workman places two halves of Ell-Jac over insulated elbow. Halves of Ell-Jac are held in place with wire while holes are drilled for sheet metal screws.



9:04 A.M. Screws are quickly inserted to hold Ell-Jac snugly and permanently in place. Childers Aluminum Ell-Jacs come in 23 standard sizes for both 90° and 45° long radius elbows.



9:06 A.M. Ell-Jac completely installed. When straight line aluminum weather-proof jacketing is added, lines have complete, maintenance-free protection for all costly insulation.

How New Childers Ell-Jacs Save You Time and Money

Revolutionary new Childers Ell-Jacs go on fast and easy . . . fit perfectly . . . cut installation costs . . . never need painting . . . and, used with Childers Jacketing, give your insulated lines that well-dressed look from end to end.

Now, aluminum elbows are made in a wide range of sizes by America's leading manufacturer of aluminum jacketing. Childers Aluminum Ell-Jacs are available for quick, easy application to protect costly elbow insulation.

Childers Ell-Jacs are two-piece, deep drawn from .020" aluminum, #3003 alloy. They are precision-formed for long-radius elbows and come in 23 sizes for both 90° and 45° ells.

Childers Ell-Jacs, together with Childers Jacketing, now let you install maintenance-free aluminum over every square foot of your valuable insulation. You protect *all* of your insulation investment at lowest cost. You get the bonus of a better looking plant and easier housekeeping.

Positive weather-proofing with Childers Jacketing is assured by exclusive Childers Lap-Seal (Patents Pending). You're sure of getting proper lap without waste. You save labor, too.

Factory attached moisture barrier protects both Childers Jacketing and Childers Ell-Jacs against corrosion that could otherwise damage the underneath side of the aluminum. Its slight extra cost is more than offset by savings in application labor.

You also get greater strength and greater protection because Childers Jacketing is cross-crimped. Cross-crimping increases the vertical strength and rigidity of a .016" sheet to that of a plain .024" sheet.

It's easy to install Childers Jacketing. All you need are pliers and screwdriver, plus inexpensive strapping. Two men can do the job. Jacketing can be removed for inspection of the lines, then reapplied without waste.

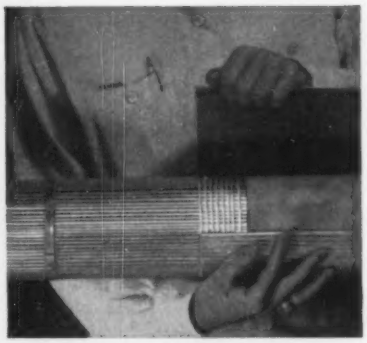
First cost is less for Childers Jacketing than for any other permanent type weatherproofing—even less than some temporary coverings.

You end maintenance worries, too, by using Childers Aluminum Weather-proof Jacketing and Ell-Jacs. Aluminum *keeps* its new look; needs no expensive periodic repainting.

Why not benefit from Childers world-wide experience when you buy insulation for your lines, towers, vessels, and tanks? More than 2,000 petroleum refining, petro-chemical, and chemical plants will endorse your decision. Childers Engineering Representatives, located in 27 major industrial centers, give professional advice on insulation jacketing.

For a free sample of Childers Aluminum Weather-Proof Jacketing, with engineering data on how to safeguard your insulation, write Childers Manufacturing Company, Dept. PR-43, P. O. Box 7467, Houston 8, Texas.

See our ad in Sweet's Industrial Construction File, Chemical Engineering Catalog and Refinery Catalog.

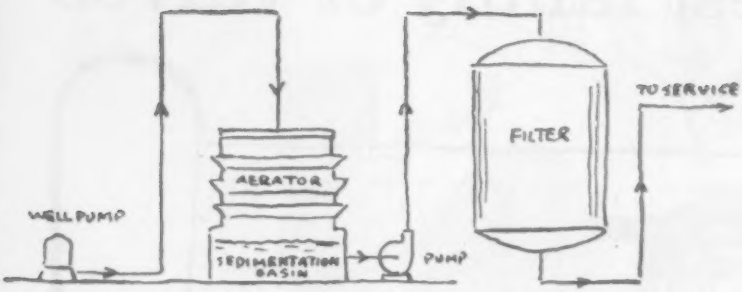


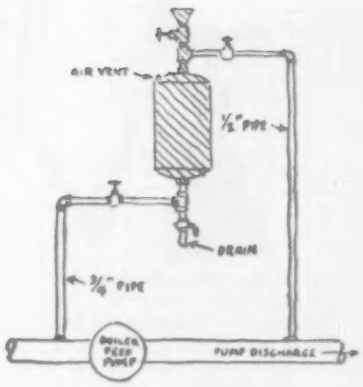
EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing an automatic measure of the 2" circumferential lap. Proper lap is assured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap-Seal and a mastic.

DEEP CORRUGATED Childers Jacketing in 1¼" and 2½" corrugations is recommended for permanent protection and improved appearance of insulated towers, vessels, tanks. Deep Corrugated Jacketing with factory-attached moisture barrier is another product available only from Childers.

$$Ca^{++} + Na_2Z = CaZ + 2Na^+$$

347832
3.06
2086992
10434960
10643 65.92

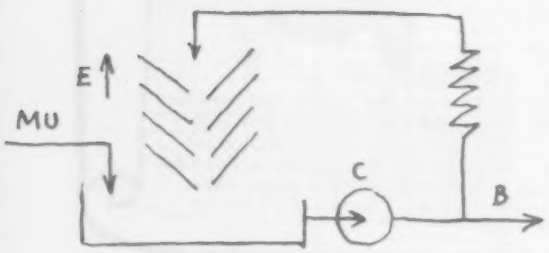




$$V = \frac{18.5D^2(S_1 - S_2)}{Z}$$

$$\frac{x}{m} = KC^{1/n}$$

any way you figure it, the best solution to your water problems is . . .



■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

BETZ LABORATORIES INC., Philadelphia 24, Pa.

POWELL

world's largest family of valves

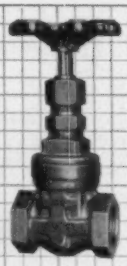


Fig. 512—Small Bronze Gate Valve for 150 pounds W.S.P. Inside screw non-rising stem. Solid wedge disc. Can also be supplied with flanged ends.

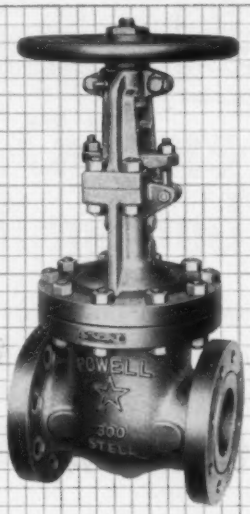


Fig. 3003—Steel Gate Valve for 300 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge Disc, screwed-in seat rings. These valves also available for 150 pounds and higher pressures.

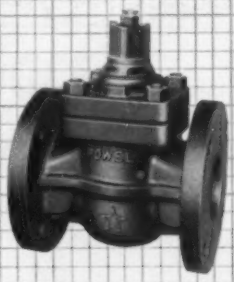


Fig. 2201—Semi-steel Lubricated Plug Valve for 175 pounds W.O.G. Single gland type. Sizes 1" to 4". Can be supplied with screwed ends. Other types and higher pressure valves are available.

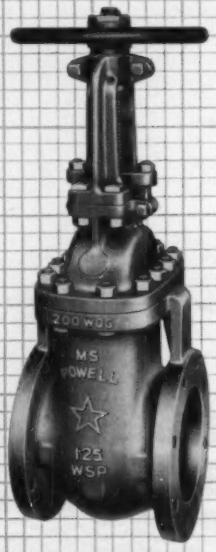


Fig. 1793—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. Outside screw rising stem and yoke. Solid wedge disc.

Fig. 1561A—New Steel Swing Check Valve for 150 pounds W.S.P. When disc is in wide open position straight, unobstructed flow area through the valve is provided.

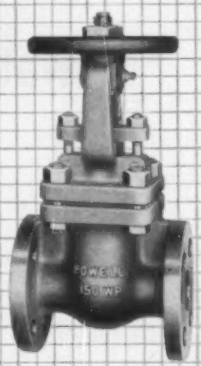


Fig. 2491—Small Stainless Steel Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke, solid wedge disc. Can be supplied with interchangeable double wedge discs. Available also with screwed ends.

NO MATTER WHAT your flow control requirements, Powell offers more kinds or types of valves, available in the largest variety of metals and alloys. Powell distributors, located in all principal cities, maintain inventories to fill almost any need. For special engineering problems, write direct to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

"YOU CAN BE REPLACED But Our P.F.I. Standards Can't"

1 Machining Backing Rings for Butt Welds
2 Dimensioning Welded Assemblies
3 Linear Tolerances Bending Radii
4 Shop Hydrostatic Testing
5 Cleaning Fabricated Piping
6 Built-up Weld, Metal Bosses
7 Welded Nozzles—Spacing
8 Preheat-Postheat Before, After Welding
9 Arc-Welding Dissimilar Ferritic Steels
10 Stress Relieving Practices

Sure it's aggravating not to find what you are looking for . . . when you need it.

But, Sir, it's easy to replace your missing file of P.F.I. Standards, just write the Institute's headquarters in Pittsburgh, using the coupon below.

While these Standards are packed with vital data on the design, fabrication and erection of industrial and high pressure—high temperature piping, they do not explain the many advantages of shop fabrication.

Shop fabrication by firms responsible for the development of P.F.I. Standards is your only real assurance of meeting the most exacting requirements of piping, whether it's welded, bent, coiled or vanstoned . . . in any metal as a component or a complete assembly.

Write for all ten P.F.I. Standards or indicate in the coupon below which ones could be helpful to you.

P.F.I.
THE PIPE FABRICATION INSTITUTE

THE PIPE FABRICATION INSTITUTE

Devoted to the Technical and Economic Problems in Piping

ONE GATEWAY CENTER, PITTSBURGH 22, PA.

Please send me the P.F.I. Standards indicated
1 2 3 4 5 6 7 8 9 10 PR

Name_____

Company_____

Address_____ City_____ State_____

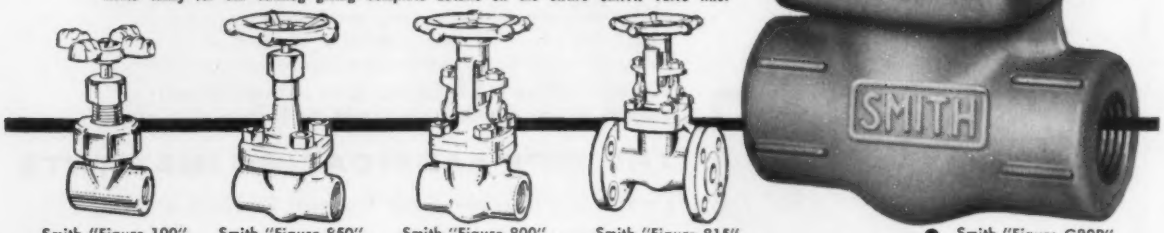
For more data on advertised products, use Readers' Service Cards, last page.

ESPECIALLY DESIGNED

for the industries they serve!

IN a large percentage of the Refineries, Chemical and Petrochemical plants in this country and Canada, SMITH Forged Steel Valves have established an enviable reputation for giving unusually long life in service. The extra stamina and strength built into all SMITH Valves is not there by accident. It is there by design — a combination of ideas and special features suggested by leading engineers — the men best qualified to know the solution to the valve problems of their respective industries. You can rely on SMITH Valves to do a better job in meeting the mounting challenge of pressures, temperatures and corrosion.

Write today for our catalog giving complete details on the entire SMITH Valve line.



Smith "Figure 100" Needle Globe Valve Sizes: ⅛" - ½" incl.

Smith "Figure 850" Inside Screw Valve Sizes: ½" - 2" incl.

Smith "Figure 800" O S & Y Gate Valve Sizes: ¼" - 2" incl.

Smith "Figure 815" Flanged End Gate Valve Sizes: ½" - 2" incl.

Smith "Figure G80R" Globe Valve Sizes: ½" - 2" incl.

NEW ENGLAND VALVE Corporation

BOX 1047 • WORCESTER, MASSACHUSETTS

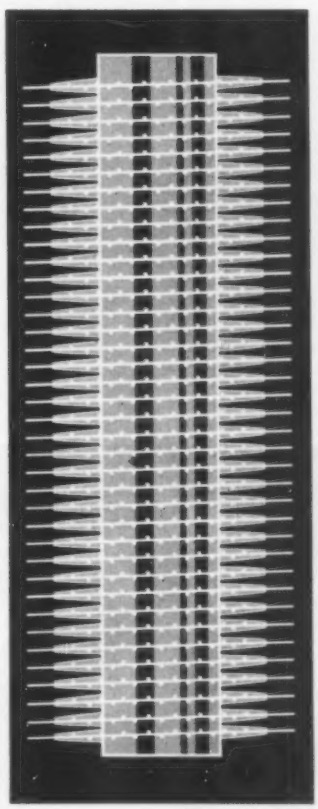
New England Valve Corp. of Canada, Ltd. Factory & offices: 1 Seneca Avenue • Port Credit, Ontario

50,000%

METAL TRANSFERS HEAT MORE THAN 50,000% BETTER THAN AIR!

Assured Performance with

SMITHCO Metalbond FINTUBE



In mechanical bond finned tubes an air gap is always present between the fin and the tube which greatly reduces efficiency. Heat expansion loosens this bond and creates an even larger air gap which further retards heat transfer.

Air gaps are avoided in Smithco Air Cooled Heat Exchangers by employing metal as the bonding agent. This metal bond provides a smooth, unbroken flow of heat from tube to fin. Smithco *Metalbond* also protects against corrosion and has proven to be the most permanent bond yet devised.

SMITHCO
Engineering Inc.

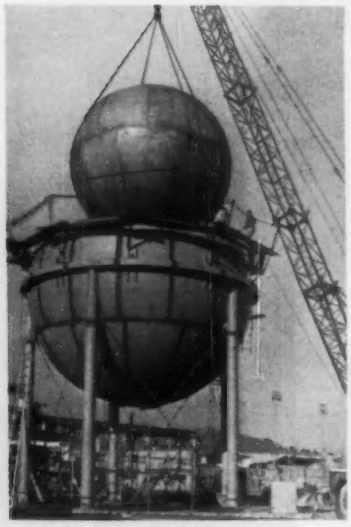
P. O. BOX 3217
TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

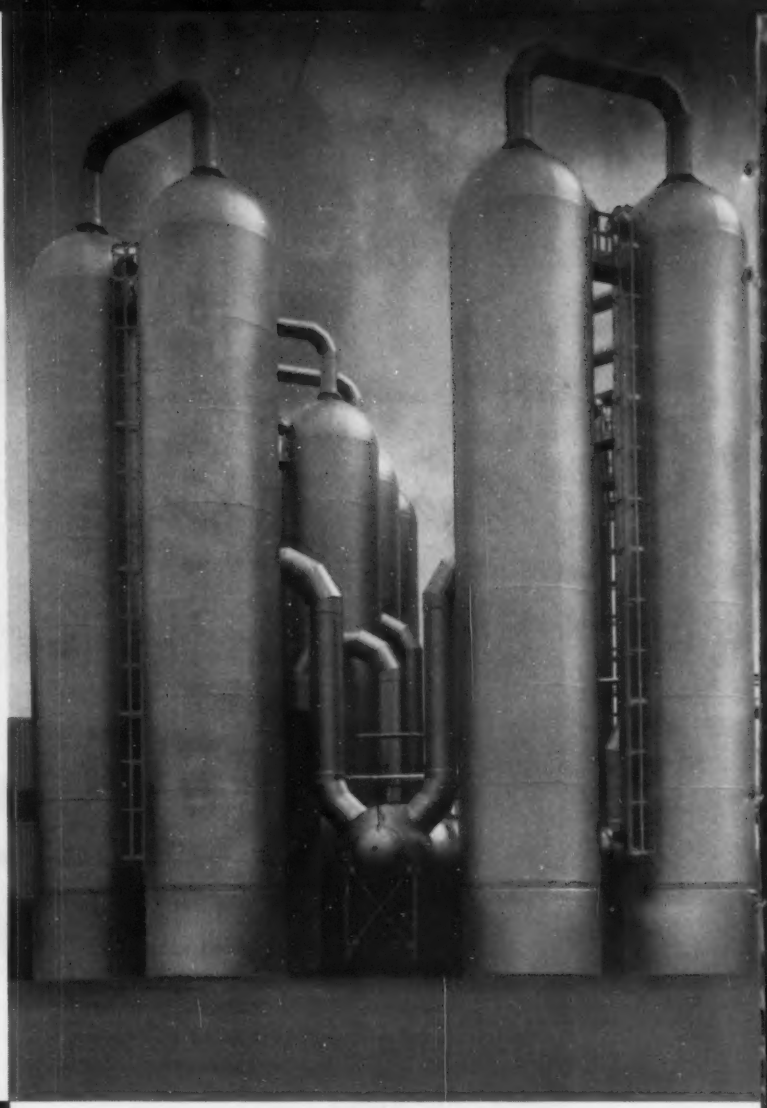
12 Vertical Pressure Vessels of T-1 Steel,
Each 63' x 11', Storing Air at 600 psia

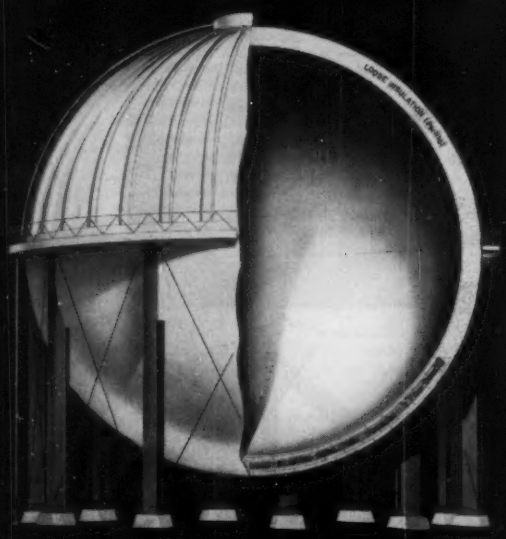
PDM

ENGINEERS · FABRICATORS · CONTRACTORS



Double Insulated Spheres for
Low Temperature Storage

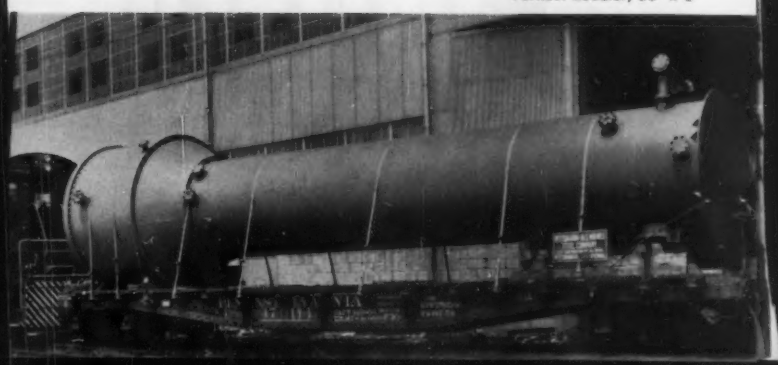




Cutaway View, Insulated Storage Sphere
for Liquefied Chlorine — 30 F.

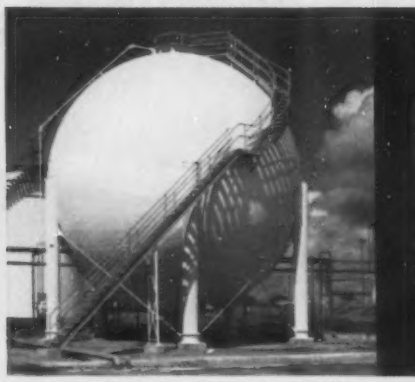
TANKS, PRESSURE VESSELS
PLATE CONSTRUCTION
STRUCTURAL STEEL
...for the Refining Industry

Vertical Reactor, 55' x 8'



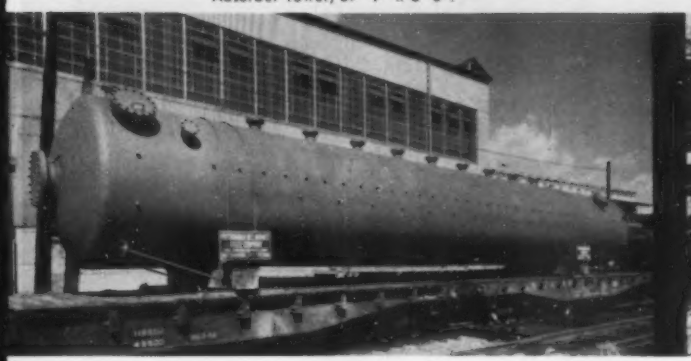
Elevated Water Storage for Compressor Stations

5000-Barrel Pressure Sphere



Flat Bottom Cone Roof Storage Tanks

Absorber Tower, 57' 9" x 8' 6".



5600 Tons of Radial Cone Bottom Mud Washers and Thickeners, Each 100' in Diameter.

Pittsburgh-Des Moines Steel Company

PRODUCTS—Tanks, A.P.I. • Tanks, floating roof • Tanks, special • Tanks, insulated • Tanks, lined • Elevated tanks • Pressure vessels • Spheres • Plate construction • Large diameter piping • Structural steel • Industrial type buildings • Steel bridges

MATERIALS—Pittsburgh-Des Moines builds tanks, vessels and structures of steel, stainless steel, stainless clad steel, alloys and aluminum

SERVICES—Pittsburgh-Des Moines' complete service to the client includes *design*, to accomplish required objectives—*selection of material*, proper for service needs—*preparation of detailed drawings*—*fabrication*—and *delivery* and *erection* or *installation*. Included also are the design, procurement and installation of all associated items such as foundations, pumps, compressors, coolers, dryers, piping, insulation, refrigeration, controls, electric wiring, etc.

SCOPE—The range of PDM product manufacture includes tanks, vessels and plate construction of plates from ⅛" to 13" thick, shop-built vessels and structures, weighing up to 100 tons, and field-assembled vessels or structures of any size.

ENGINEERING—The development, design and coordination required for successful completion of the widely varied work of the Company are functions of our Engineering and Research facilities. Our engineering groups comprise men outstanding in creative engineering, structural design, stress analysis, metallurgy, welding techniques, physics, gas dynamics, heat exchange, mechanical, electrical and control work.

RESEARCH—PDM Research investigates problems encountered in engineering for which known data or criteria are not available. A large part of our research is devoted to product improvement and the solution of new problems created by unusual and advanced projects undertaken. Materials and conditions for storing various chemical substances, protective coatings for structures and vessels, heat exchange rates and insulation values, etc., are tested and evaluated. From these studies and much related work has come a wealth of data advancing our ablity to serve our customers with better structures at the lowest levels of cost.

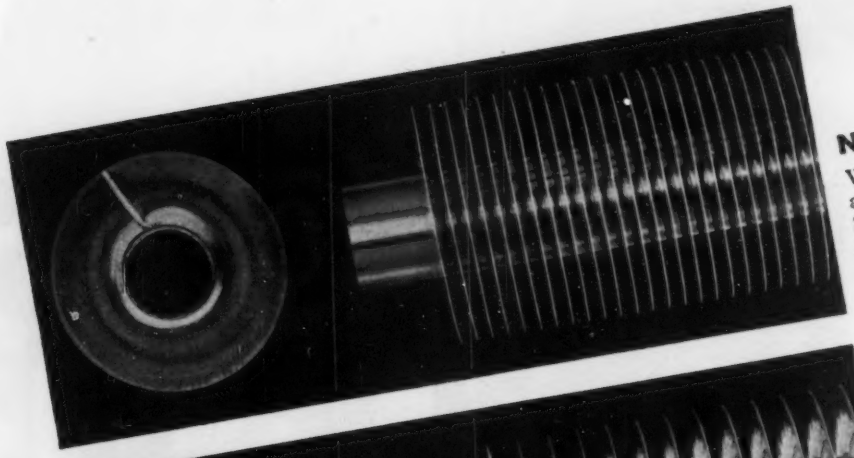
INQUIRIES—We invite your inquiries and the opportunity to quote on steel tanks, platework and structural steel fabrication of every type, including design studies, research, engineering, and erection. Consultations will gladly be arranged at your convenience, without obligation of any kind. Write, telephone or wire our nearest office.

Pittsburgh-Des Moines Steel Company

Plants at PITTSBURGH, BALTIMORE, DES MOINES, SANTA CLARA, FRESNO, and STOCKTON, CALIF.

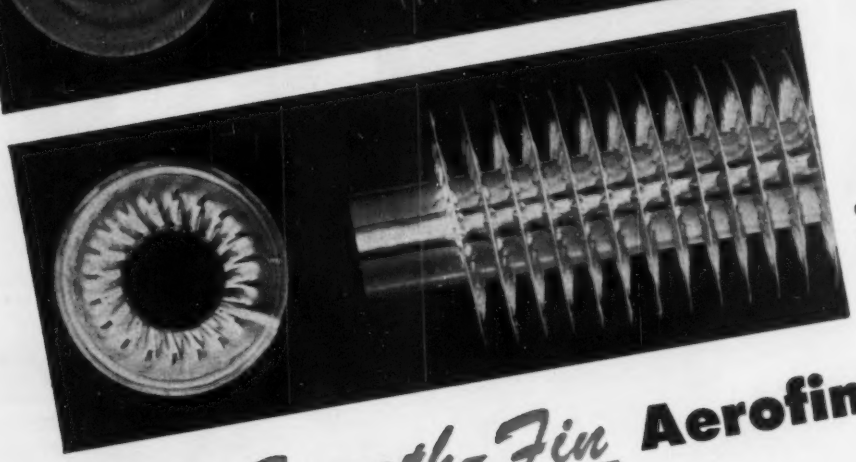
Sales Offices at:

PITTSBURGH (25).....3482 Neville Island
BALTIMORE (26).....Curtis Bay Station
NEWARK (2).....1763 Military Park Bldg.
CHICAGO (3)..686 First National Bank Bldg.
EL MONTE, CAL.....P. O. Box 2012
ATLANTA (5)....361 E. Paces Ferry Rd., N.E.
DES MOINES (8).....983 Tuttle Street
DALLAS (1).....1287 Praetorian Bldg.
SEATTLE (1).....Suite 390, 500 Wall St.
SANTA CLARA, CAL.....689 Alviso Road
DENVER (2).....323 Railway Exchange Bldg.



New Smooth Fins

Wide base provides ample contact surface. Smooth fins can be closely spaced without increasing resistance.



Old Type Fins

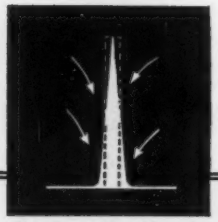
Crimped to provide necessary contact surface, widely spaced to reduce air friction.

NEW *Smooth-Fin* Aerofin Coils for Greater Capacity— Lower Resistance

Aerofin extended-surface heating and cooling coils now offer you an even greater area of effective surface — even greater capacity — per square foot of face area. Airway resistance is lowered; higher air velocities can be used. The result is extremely high heating or cooling capacity in a given space.

Compact, sturdy, standardized encased units arranged for simple, quick, economical installation.

Write for Bulletin S-55

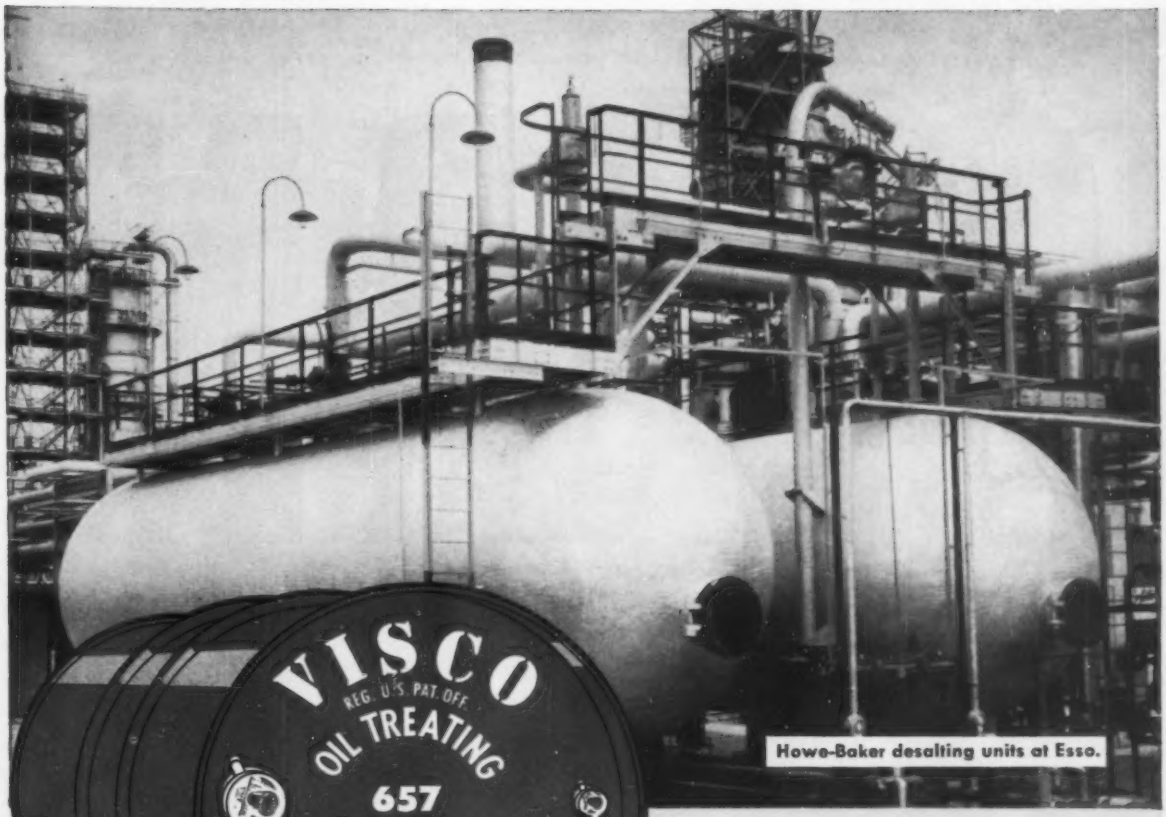


The new Aerofin smooth fins are tapered, with wide base that conducts sufficient heat between fin and tube to make the entire fin effective transfer surface.

AEROFIN CORPORATION

101 Greenway Ave., Syracuse 3, N. Y.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.



Howe-Baker desalting units at Esso.

desalting results

. . . a foregone conclusion at Esso's Bayway Refinery

The modern equipment shown above is one of the recent additions to the Esso Standard Oil Company Refinery at Linden, New Jersey.

With equipment such as this, plus the familiar blue barrels of Visco, outstanding desalting results are a foregone conclusion.

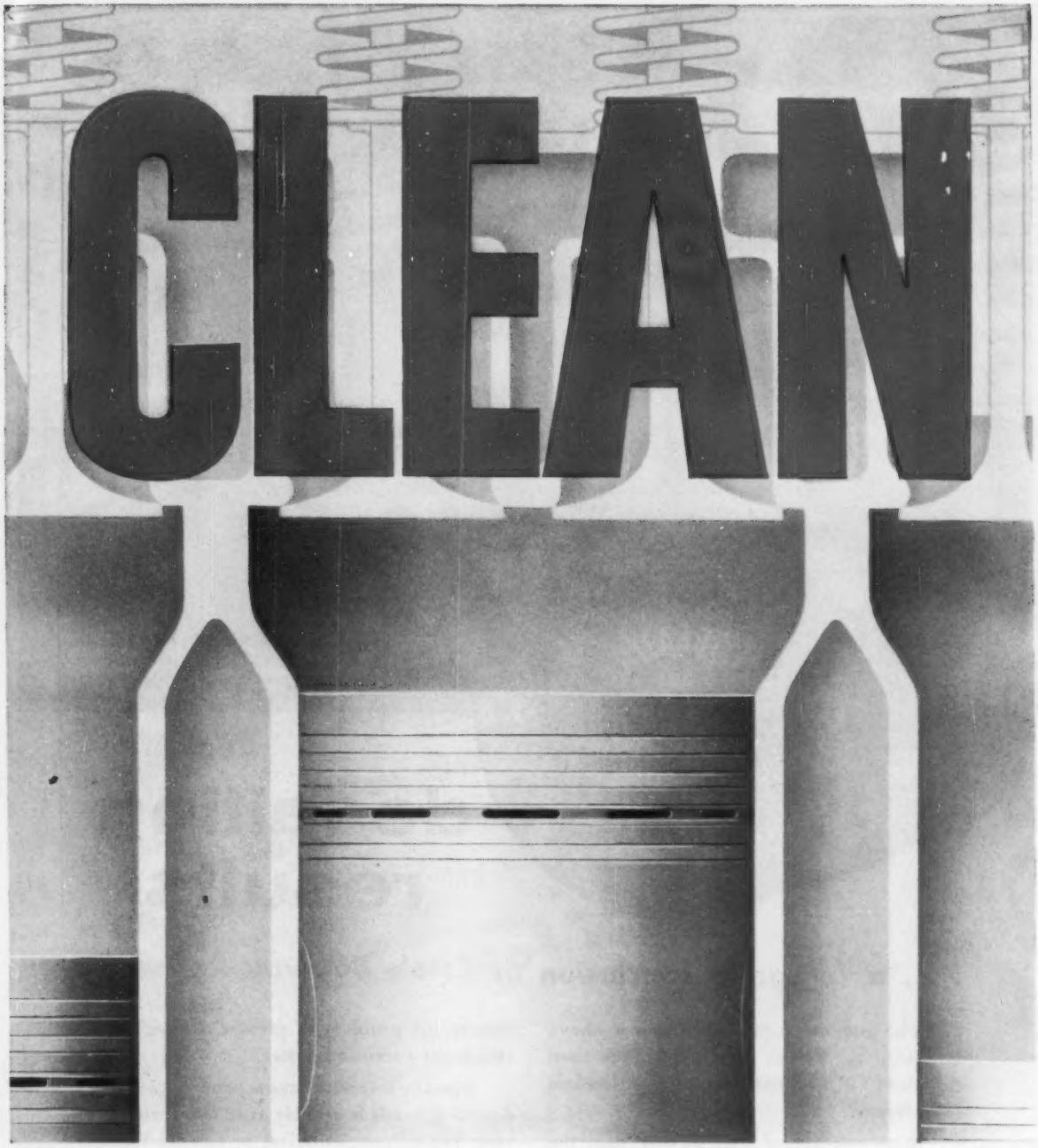
Visco, in either electrical or salt settling equipment, still provides the consistently efficient — and economical — chemical solution to the problem of greater throughput and lower corrosion costs.

Specific information on your particular desalting needs is readily available through your Visco Representative, or contact Visco direct.

VISCO PRODUCTS COMPANY
INCORPORATED
1020 Holcombe Blvd. Houston 25, Texas
JAckson 8-2495

Visco **CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS**

For more data on advertised products, use Readers' Service Cards, last page.



PARANOX-BLENDED OILS HELP KEEP ENGINES CLEAN!

Ordinary lubricating oils take a beating in big, hard-working heavy-duty engines. High temperature, open-throttle operation causes hard varnish formations and oxidation breakdown. Low-temperature, short-period use causes wet sludge and deposits. Oils blended with *Paranox*® stay *clean* and *lubricate* at *all* temperatures for better performance and longer periods between overhauls.

Enjay has developed the *only complete line* of high quality additives (Paramins®). To meet the most exacting lubrication specifications, insist on Enjay Paramins.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st St., New York 19, N. Y. • Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

where trouble-free performance is a matter of pride...

DOW CHEMICAL COMPANY, TEXAS DIVISION, FREEPORT, TEXAS

Heat exchanger tube

One of the largest of The Dow Chemical Company's manufacturing installations is the Texas Division, where, in complex and brilliantly-painted plants hundreds of different components are processed and re-shaped to produce more than 40 fundamental chemical products.

Chemical process condensers such as this at The Dow Plant, Freeport, Texas, are vital links in the production chain and are tubed with Cupro-Nickel, 30% Heat Exchanger Tubes.

Combining excellent corrosion-resistant properties with very favorable mechanical properties, Scovill Tubes of this alloy make an important contribution to the trouble-free operation of these key units under very exacting service conditions.

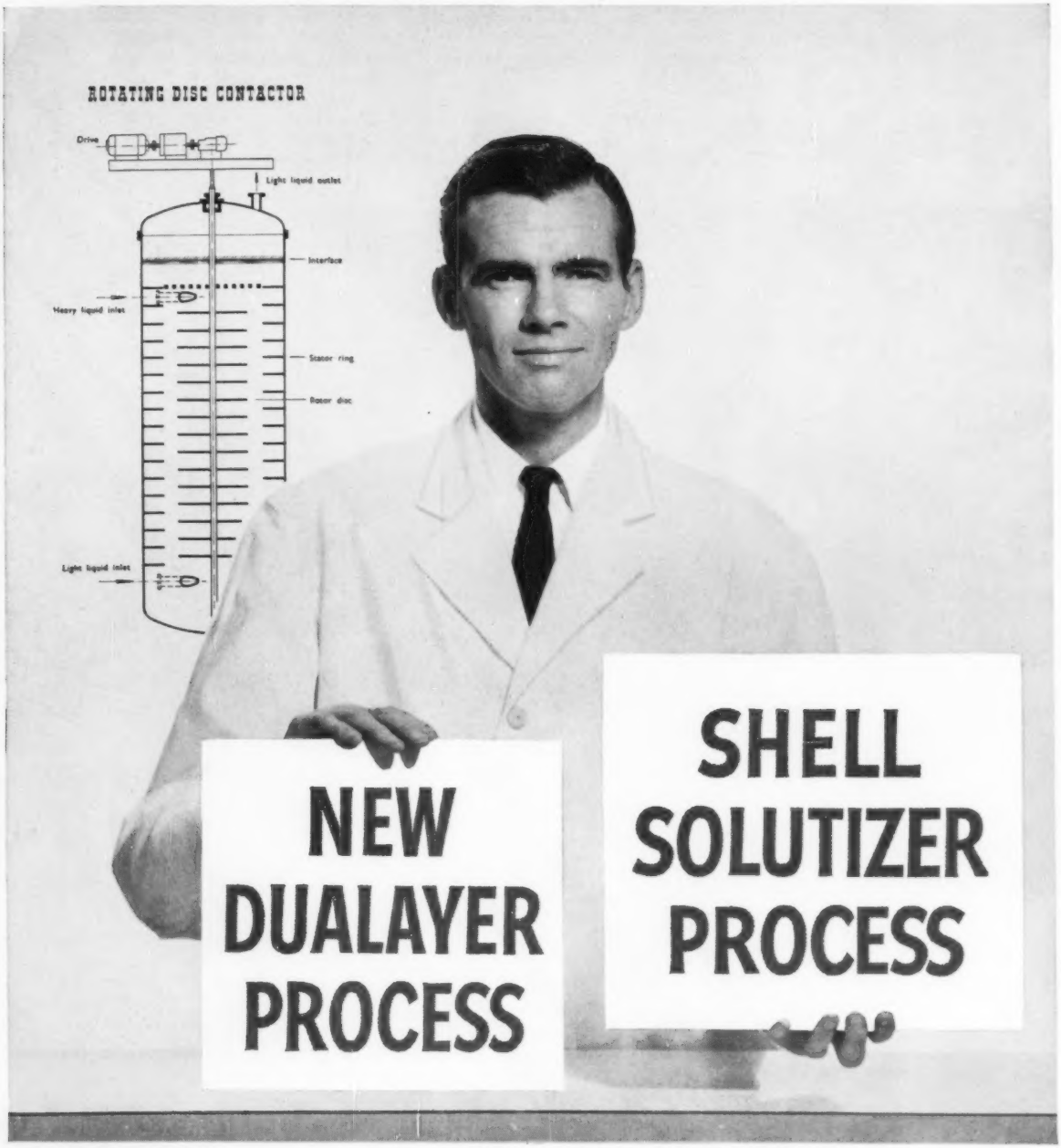
Let Scovill Technical Service . . . most experienced in the field . . . help you establish the best heat exchanger tube specifications for equally trouble-free service in your own heat transfer equipment.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

HEAT EXCHANGER TUBE for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

SCOVILL MANUFACTURING COMPANY, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

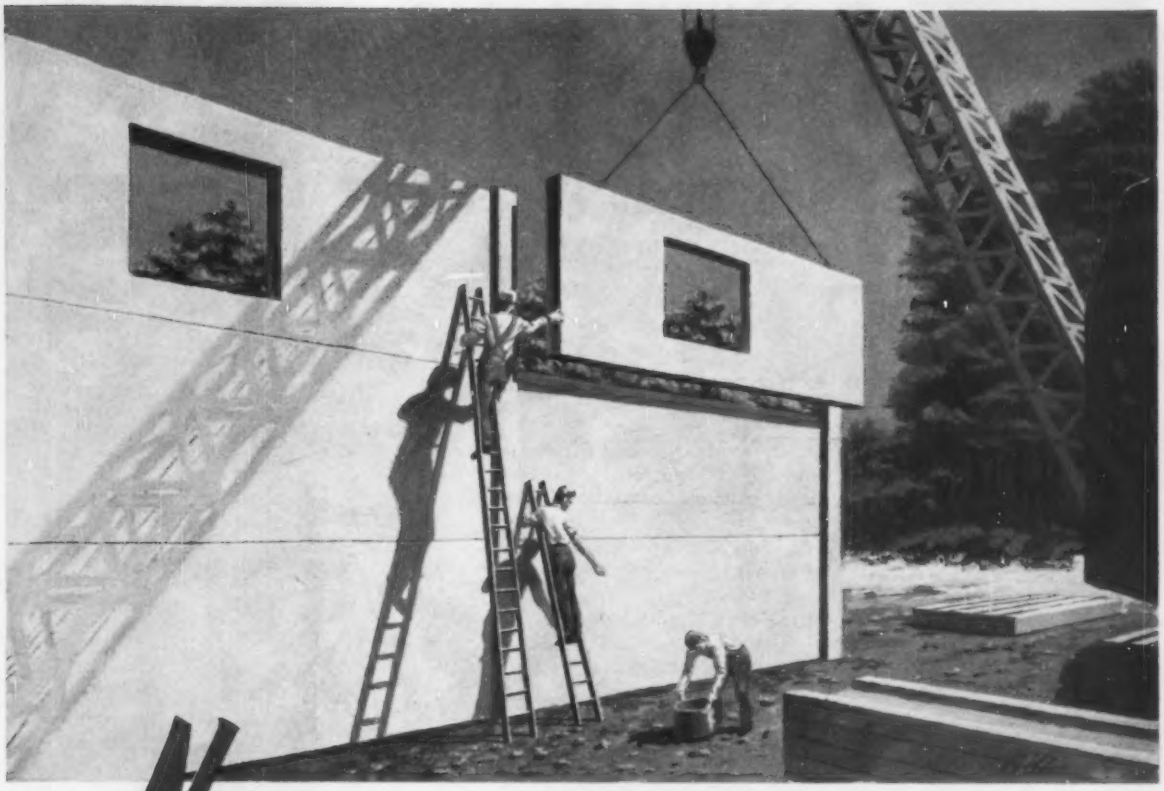
98C58



Now Shell offers <u>two</u> packages to boost octane

Either process removes mercaptans almost completely at a cost of only a fraction of a cent per gallon. You save enough in TEL to pay this sweetening cost several times over. The same TEL dosage goes farther—gives you extra octanes cheaper than any other way. Both processes are now available for license. To find out which process is best for your operation, write Shell Development Company, 50 West 50th Street, New York 20, New York.

SHELL DEVELOPMENT COMPANY



Now Permanent Concrete Buildings

Erected in Hours!

DESIGN—Rackle provides professional assistance in building design and all phases of engineering.

MANUFACTURE—4000 to 5000 PSI lightweight Haydite concrete is conventionally reinforced and/or prestressed by Swiss-patented BBR system. Strict production and laboratory control insures positive strength in Rackle members.

DELIVERY—Rackle trucks deliver structural components to jobsite as soon as the foundation is poured.

ERECTION—Units are put into place as quickly as they are delivered. Columns are set first. Then beams. Finally channel roof deck. Small buildings can be set in 8 hours; a 30,000 sq. ft. warehouse in 40 to 60 hours.

FINISHING—Six inch thick pre-cast wall panels with plain or textured surfaces can be installed rapidly, or you can use any other architectural treatment you prefer.

From design to finished product, Rackle provides a complete concrete building engineered to individual specifications with speed and economy.

Rackle's new engineering and production technique makes *extra speedy* construction possible with permanent, maintenance-free concrete.

Engineered and cast to individual specifications at our Houston plant, Rackle structural members are trucked to your building site and erected in a matter of hours.

Initial cost is surprisingly low because of speed of construction, and when you build with concrete you continue to save for many years because concrete requires little or no maintenance and insurance rates are lower, too.

Write or call today for literature on building with Rackle.

THE RACKLE COMPANY OF TEXAS

PO BOX 15008 • HOUSTON • OR 2-1736

Serving the Texas Gulf Coast Only

Manufacturers of quality concrete products since 1870 . . . a wholly owned subsidiary of the Geo-Rackle and Sons Co., Cleveland, Ohio.

For more data on advertised products, use Readers' Service Cards, last page.

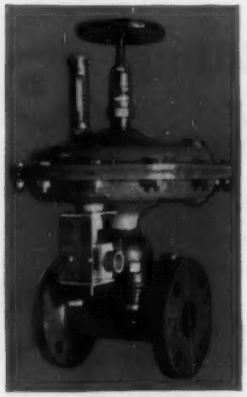
CONTROL VALVES BY CONOFLOW

YEARS AHEAD IN DESIGN

SERIES S CONTROL VALVES

Specifically designed to handle the tough services which cause ordinary valves to fail.

- Sizes to 14"; pressure ratings to 2500 lbs.
- Extra heavy body construction exceeds ASA standards.
- Self-sealing bonnet will not leak regardless of temperature or pressure conditions.
- Patented Rotomotor actuator handles large sizes with high power requirements.



SERIES HB SAUNDERS VALVES

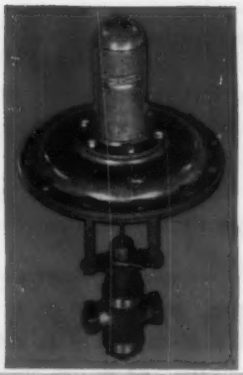
Original close-coupled design introduced by Conoflow has long been an industry standard.

- Completely engineered factory assemblies assure premium performance.
- Actuators for on-off or throttling control in all valve sizes.
- Exclusive Bonnet Loading System available for higher thrust outputs.
- Compact construction allows for more economical piping arrangements.

SERIES LB CONTROL VALVES

Quality construction and truly integrated body-actuator design completely outmodes conventional control valves.

- Cono J Positioner sets new industry standards for precise proportional positioning.
- Rugged cylinder actuator utilizes sturdy metal piston and exclusive lipseals which cannot leak.
- Single-seat body design guarantees positive, tight shut-off under any conditions.
- "Lift-out" seat ring can be replaced quickly with a minimum of effort.
- Extra thick body walls give added protection against corrosion and erosion.
- Simplified construction means less replacement parts and substantial inventory savings.



SERIES AB CONTROL VALVES

A line of economical control valves for handling small flows.

- Bodies available in two and three-way design, in all alloys.
- Extra long stroke; double that of conventional valves.
- Suitable for high pressures and corrosive services.
- Completely enclosed spring-over-diaphragm construction is compact and protects spring from atmospheric corrosion.

When you specify Conoflow control valves you get the best valve available for your control application. Write for literature or let us put you in touch with a Conoflow representative qualified to help solve your control problems. Conoflow Corporation, Dept. C-805, 2100 Arch Street, Philadelphia 3, Pa.

SEE US AT THE ISA SHOW—BOOTH 1246

Cono-Controls®

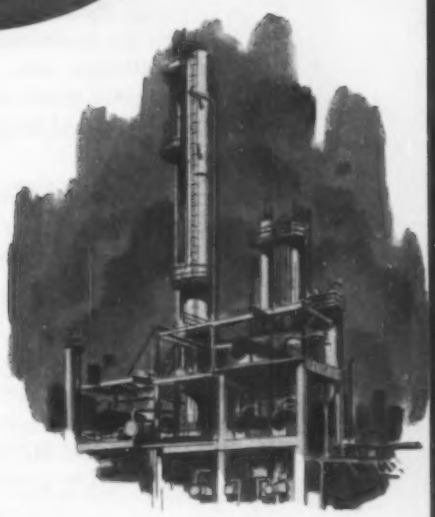
CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

Subsidiary of Walworth

Consistency is TRADITIONAL at WESTERN

Consistency is vital to HF ALKYLATION



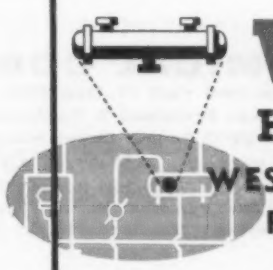
In this commercial use of hydrofluoric acid as a catalyst for the alkylation of olefins with isobutane, *consistent high quality of product* is of paramount importance in this well-established process.

HF Alkylation for the production of high octane motor fuel blending components demands *equal consistency* in the performance of the heat transfer equipment used to cool the reacting streams.

Western Heat Exchangers are characterized by consistency throughout their design and manufacture—from initial rating to completed fabrication.

Whatever the heat transfer requirement of your process, a proposal from Western should be your first consideration.

Water cooling of reacting streams is being efficiently handled by Western exchangers in many HF Alkylation units currently in operation.
There is a Western representative ready to serve you—**today.**



WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma

MAJOR SOURCE OF MAJOR ACIDS

SULFURIC ACID

Commercial Grades of 77.67 to 122.5% H_2SO_4. *"Special Grade"* concentrations of 93 to 100% H_2SO_4 with iron guaranteed less than 50 ppm and similarly low content of nitrogen, arsenic and other impurities. *Electrolyte Quality* at Sp.Gr. 1.300, 1.360, 1.400, 1.500 and 1.835. *Oleum* in all concentrations from 15% free SO_3 to 100% Liquid SO_3 (equivalent to 103.38 to 122.5% H_2SO_4). *Regenerated* Acid sludges are decomposed, regenerated and delivered as water-white 98% H_2SO_4 on an established contract basis. *Spent Acids* from the manufacture of white oils, fuels, chlorine gas, alcohols, DDT, butadiene and other products are recovered, regenerated or fortified for re-use at the source or for different use. In any case, Stauffer processing and contract arrangements eliminate waste, eliminate air and stream pollution or the alternative of in-plant conversion of process residues.

MURIATIC ACID

Delivered in standard strengths of 18°, 20° and 22° Bé corresponding to 27.92, 31.45 and 35.21% HCl. Stauffer also offers an extremely high-purity, high-analysis grade of muriatic acid for special uses. All grades are available in tank cars, tank trucks and carboys.

NITRIC ACID

Commercial Grades of 38°, 40° and 42° Bé corresponding to 56.52, 61.38 and 67.18% HNO_3. *Engravers' Quality* of the same concentrations is conditioned to prevent fuming and discoloration of etching plates.

HYDROFLUORIC ACID

Anhydrous, is shipped in 22-ton and 42-ton tank cars, and in 100- and 200-pound cylinders from the Nyotex Chemicals Division of Stauffer Chemical Company at Houston; aqueous acid from the Stauffer plant at Louisville, Ky.

80 YEARS OF SERVICE TO INDUSTRY

testify to Stauffer Chemical Company's reliability as a major source of volume acids and an authoritative source of information on their use and handling.

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York
636 California Street, San Francisco 8, California
Consolidated Chemical Division: 6910 Fannin Street, Houston, Texas

Stauffer's Sulfuric Acid is shipped from Mobile, Ala., Los Angeles and Richmond, Cal., Hammond, Ind., Baton Rouge, La., Baytown, Fort Worth and Houston, Tex., and various stock points. Hydrochloric Acid is shipped from Richmond, Cal., and Fort Worth; Hydrofluoric Acid (anhydrous) from Houston; (aqueous) from Louisville.

Stauffer CHEMICALS SINCE 1885

For more data on advertised products, use Readers' Service Cards, last page.

YOU CAN BUY THESE 9 CATALYSTS FROM A SINGLE SOURCE!

Stauffer is a major source of metal chlorides and other catalysts widely used in the Petroleum and Chemical industries. Wide distribution of manufacturing and warehouse facilities assures a continuous, dependable and *flexible* source . . . a *single* source for all these important catalysts.

STAUFFER CHEMICAL COMPANY

380 MADISON AVENUE, NEW YORK 17, NEW YORK
PRUDENTIAL PLAZA, CHICAGO 1, ILLINOIS
636 CALIFORNIA STREET, SAN FRANCISCO 8, CALIFORNIA
P. O. BOX 9716, HOUSTON 15, TEXAS

Stauffer CHEMICALS SINCE 1885

ALUMINUM TRICHLORIDE — Various mesh sizes in drums of 50 to 600 pounds net, and in bulk. Also in solution.

ANTIMONY CHLORIDES — Both solid and flake (anhydrous) in drums of 25 to 700 pounds net. Liquid pentachloride in drums of 25 to 700 pounds net, in tank trucks and tank cars.

BORON TRICHLORIDE — In low-pressure cylinders of 100 and 1800 pounds net; also in tank cars. 6-pound cylinders for experimental use.

HYDROCHLORIC ACID — Anhydrous HCl available in tube trailers or cylinders from Los Angeles, Calif., and Fort Worth, Texas.

HYDROFLUORIC ACID — Anhydrous HF available in tank cars of 22- and 42-ton capacity, and in 100- and 200-pound cylinders, from Stauffer's Nyotex Chemicals Division at Houston; aqueous acid in drums and tank cars from Louisville.

SULFURIC ACID — Commercial grades at concentrations of 77.67% up to 122.5%. Oleum at various strengths from 15 to 65% free SO_3; also liquid SO_3. By pipeline, barges, tank cars and tank trucks from factories at Mobile, Ala.; Los Angeles and Richmond, Calif.; Hammond, Ind.; Baton Rouge, La.; Baytown, Fort Worth and Houston, Tex., and various stock points.

TITANIUM TETRACHLORIDE — Technical and C. P. Tank cars and tank trucks; 10-gallon and 55-gallon drums of 130 and 725 pounds net from Niagara Falls, New York.

TITANIUM TRICHLORIDE (Anhydrous) — Available in 1-, 5- and 55-gallon drums packaged under argon atmosphere f. o. b. Richmond, Calif.

LITERATURE AVAILABLE

METAL CHLORIDES:

Send for copy of a new and authoritative book on Metal Chlorides. There are sections on chlorides of silicon and zirconium in addition to those described above.

HYDROFLUORIC ACID:

16-page brochure with many graphs and tables and a 24-page pocket-size booklet on Safe Handling and Analytical Methods.

For more data on advertised products, use Readers' Service Cards, last page.

YEAR 'ROUND BONUS!

You Get More Than Just a Valve When You Buy BS&B's Super 70

Specification of BS&B Super 70 Diaphragm Control Valves on your next job will assure you of getting all of the following:

1. High Quality Product . . . The BS&B Super 70 Diaphragm Control Valve has high efficiency and stability. In addition to thousands of hydraulic flow tests performed in the laboratory, analysis of operating data gathered from Super 70's on stream in customer plants substantiate their excellent performance.

2. Application Engineering . . . Today's complex processing problems require detailed analysis to determine proper instrumentation and control applications . . . accurate control valve sizing. This is a regular service to Super 70 customers.

3. Start-up Assistance . . . After helping customers select the right valve for a specific job, BS&B follows thru by assisting at plant start-up time.

4. Time-saving Scheduled Maintenance . . . With the patented clamp ring—float ring closure, valve maintenance can be done in a fraction of the time required by conventional type valves . . . an economic must in future valve specifications.

Clamp Ring—
Float Ring Closure

Flanged—
Gasket Closure

BS&B Super 70 Valves are available in either clamp ring—float ring, sealed bonnet or flanged-gasketed body closures. Whichever type you choose, when they're "on stream" you'll *know* that they're exactly right for the job.

Call your nearest BS&B office or representative now to discuss your present and future valve requirements. Or if you prefer, write for detailed information.

OVER 60 YEARS BS&B ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-F9

7500 East 12th Street

Kansas City 26, Missouri.

For more data on advertised products, use Readers' Service Cards, last page.

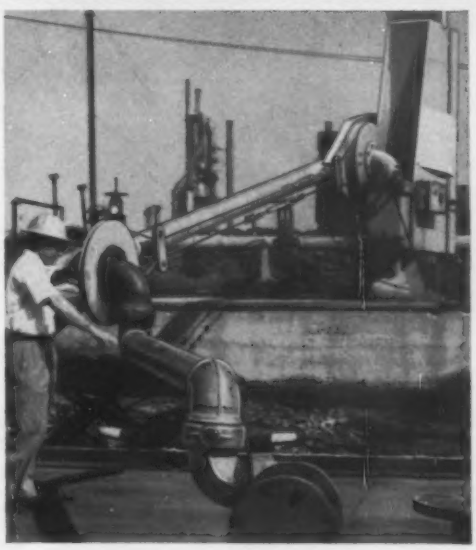
CHIKSAN

PREVENTS LINE HANDLING INJURIES
SPEEDS BARGE LOADING
ELIMINATES HOSE BURSTS
SLASHES REPLACEMENT COSTS

The Chiksan Barge Loading Arm ends hazardous manhandling of loading hoses, eliminates dangerous dock clutter. Mechanical operation makes hookup fast and simple.

Gear reduction enables one man to adjust the flange position anywhere in a 105° vertical range. Outboard arm is manually swung into position at any point in a 130° horizontal arc. The eight inch model rotates 360° to permit servicing barges on both sides of a narrow dock. Once hookup is made, the arm can be left unattended while free wheeling allows the unit to ride free during loading and unloading. When not in use, the arm is raised up and out of dockside traffic.

6″ x 25′ and 8″ x 28′ sizes available. Handle petroleum products, both black and bright, and mild caustics in any temperature ranging between —60° F. to +225° F. Service all river and lake barges and lake tankers including those in 25,000 barrel class.



The Chiksan Barge Loading Arm is designed to reach approximately 20 feet from dock riser to barge flange. Total length of Arm is 25 feet.

fmc CHIKSAN
A SUBSIDIARY OF
FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY — BREA, CALIFORNIA
CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas
Subsidiaries: Chiksan Export Company
Chiksan of Canada, Ltd.

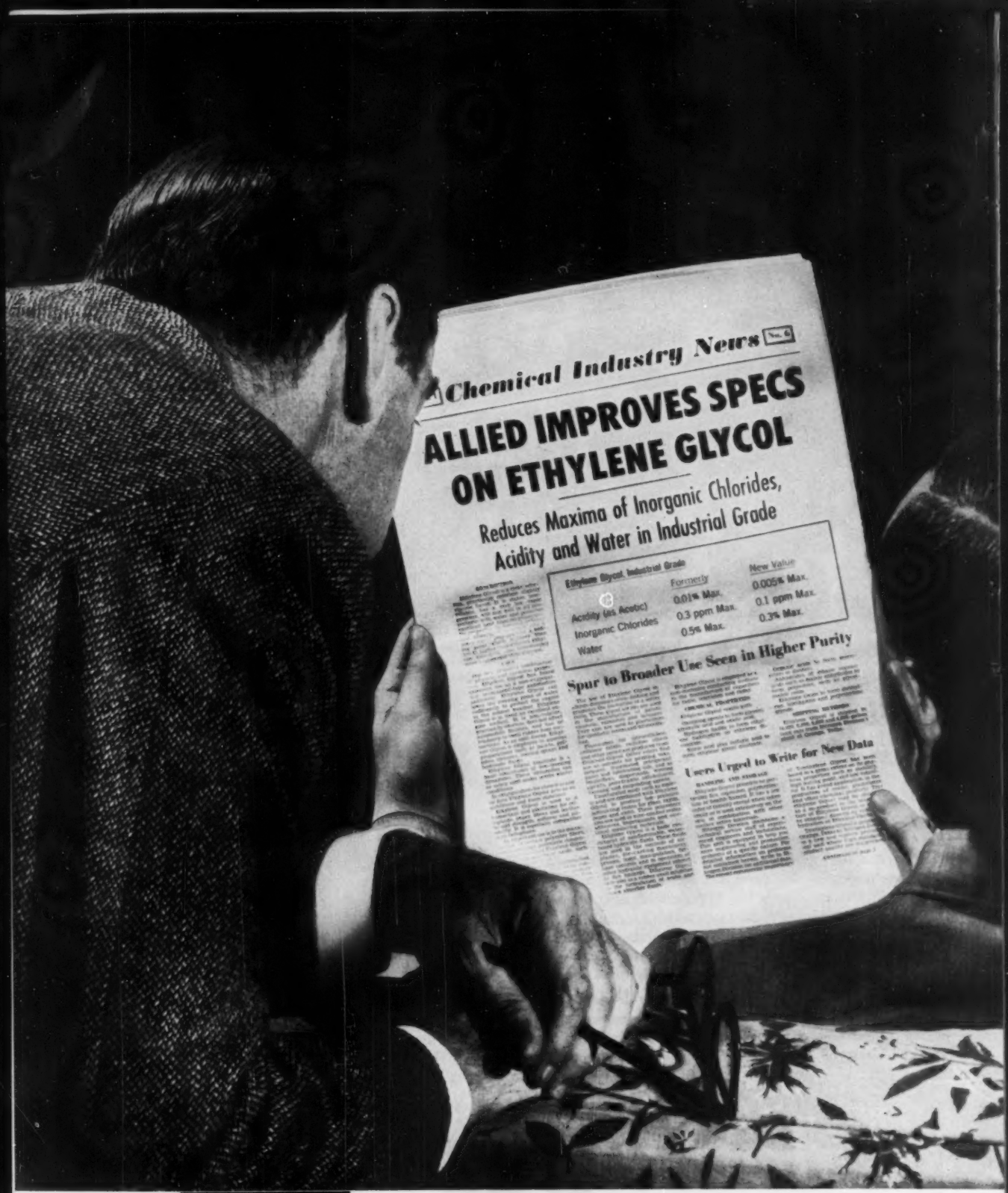
58-36

CHIKSAN COMPANY
330 No. Pomona Ave., Brea, Calif.

Please send me your Barge Loading Arm Bulletin #456.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.



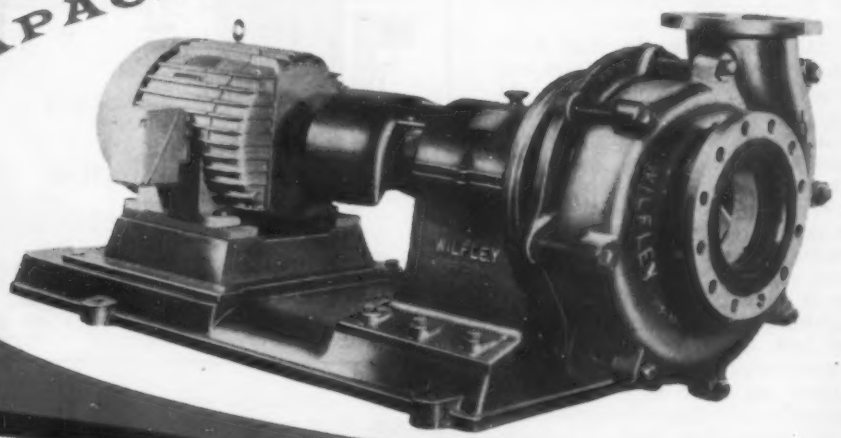
Allied Chemical

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde U. F. Concentrates—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Ammonium Nitrate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

Nitrogen Division • Department G 3-21-1 • 40 Rector Street, New York 6, New York

NEW! WILFLEY 8 INCH ACID PUMP

CAPACITIES TO 3000 GPM!



SUPERIOR PERFORMANCE!

Now Wilfley's famous line of Model "AF" Acid Pumps includes 1" to 8" discharge sizes with 10 to 3000 GPM capacities, and heads up to 200'! This new 8" pump incorporates the same dependable, economical features that characterize all Wilfley Acid Pumps . . . **continuous, trouble-free operation, lower maintenance costs, longer pump life, higher output.**

Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

INDIVIDUAL ENGINEERING ON EVERY APPLICATION

Write, wire or phone for complete information.

Wilfley Sand Pumps
"Companions in Economical Operation"
Wilfley Acid Pumps

A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U. S. A. • P. O. BOX 2330 • NEW YORK OFFICE: 122 EAST 42ND STREET, NEW YORK CITY 17

For more data on advertised products, use Readers' Service Cards, last page.

One of a series.

Some Things to Think About Steam Traps

...in order to get high operating efficiency and a minimum of maintenance

The gentleman who invented the wheel had a basic idea and so far no one has come up with anything better for the purpose.

If you'll pardon us for a little overemphasis on the significance of steam traps, we'd like to liken one of them to the wheel.

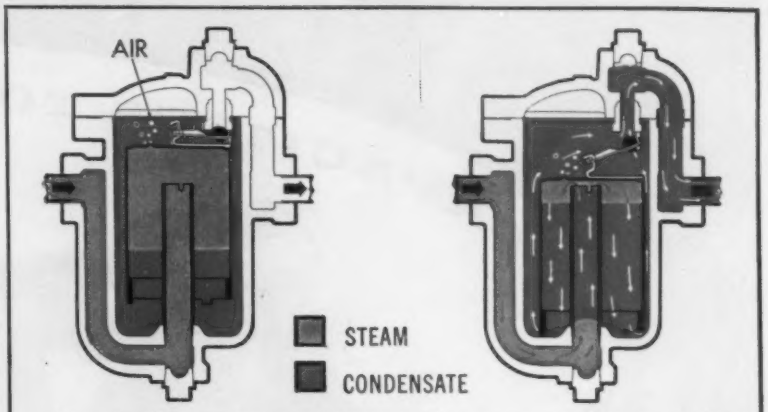
In 1911, when the first Armstrong inverted bucket steam trap model was announced to the world, or at least that part of the world that modest advertising and sales budgets would cover, it was not received with equal enthusiasm by all (especially old-style trap makers). But, like the wheel, it managed to find its way into general use. And, nothing better has ever turned up for the purpose of draining condensate. As a matter of fact, the Armstrong trap has been very widely copied. Today, there are more inverted bucket traps draining process equipment than any other kind. Of these, there are more Armstrongs.

If this sounds like the boasting of a proud parent, give consideration to some fundamental requirements not met by all traps:

1. ***A steam trap should not leak steam.*** Some traps do, you know, because of the nature of their operating principle. No steam ever gets to the Armstrong trap orifice. The valve is always water sealed.

2. ***A steam trap should vent "air" as fast as it accumulates***—otherwise temperatures are reduced and corrosion is a problem. The Armstrong trap handles air very nicely. The vent in the bucket permits air to accumulate in the top of the trap, from where it is discharged when the trap opens. For extreme conditions like draining paper machine dryers, some jacketed kettles and certain other units, the vent is sized larger for the job. And, for handling big volumes of air during warm-up, a bucket with an auxiliary thermic vent really speeds up heating.

3. ***A steam trap should discharge condensate at steam temperature*** if you want to get maximum efficiency from the unit drained. And most people certainly do. If you have to wait for the condensate to cool, it's almost impossible to maintain maximum temperatures and prevent air build-up. You guessed it—the Armstrong trap opens for water, without dependence on temperature.



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

4. ***A steam trap should be suitable for any return system.*** The Armstrong trap works just the same whether discharging to atmosphere, back pressure or vacuum. It has been conclusively proved that flash steam resulting from use of a bucket trap does not cause a problem in vacuum return systems. The flash condenses rapidly. It's the leaky traps that cause the headaches.

5. ***A steam trap should not be a "prima donna".*** Some kinds of traps take an awful lot of care and coddling. The Armstrong trap is a rough and ready type with a hardened chrome steel constitution (valve and seat, to be exact). It cleans itself of ordinary dirt and scale without choking up. Its 18-8 stainless parts stave off rust and corrosion. It resists wire-drawing and wear remarkably well. In fact, it stays on the job longer with less attention than any trap ever produced. Unless you live in Siberia, you can probably find a user around the corner who will tell you so from experience.

6. ***A trap should not be an "orphan".*** With Armstrong traps you can *always* get prompt service and parts from nearby Factory Representatives and stocking distributors as well as from the factory.

7. ***A trap should have a guarantee.*** The Armstrong trap is unconditionally guaranteed to give you *complete satisfaction* (as to doing its job, that is). If it doesn't, you can get your money back.

If you'd like to buy some of these excellent steam traps, call your local Armstrong Representative or write **Armstrong Machine Works, 8525 Maple St., Three Rivers, Michigan.**

ASK FOR the 44-page Steam Trap Book, free on request without obligation.

ARMSTRONG STEAM TRAPS

For more data on advertised products, use Readers' Service Cards, last page.

OPERATION PROVES
It's Cleaner Gas with
PEERLESS
SCRUBOSPHERES

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

Operation of these four 66" I.D. Scrubospheres has demonstrated their superiority over conventional oil bath dust scrubbers. The dust removal ability of the SCRUBOSHERE is outstanding because it utilizes wetted surfaces for dust collection which are more closely spaced than in conventional equipment.

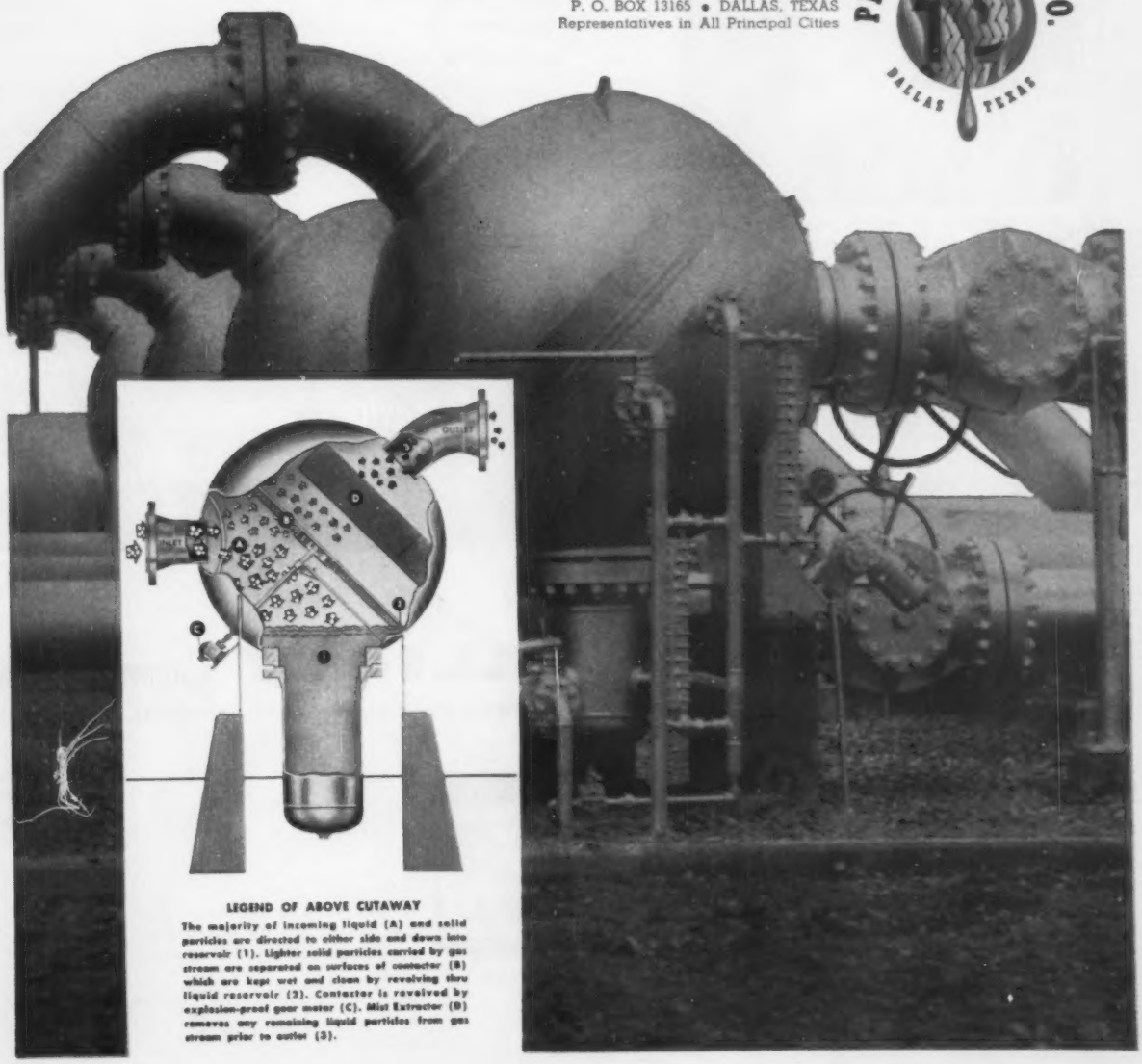
Operation of these Peerless units has also proven their superiority with respect to minimum oil loss, because oil is periodically removed from the Scrubospheres whereas **it must be periodically added to other scrubbers** in the same plant operating under comparable conditions. Patent applied for.

Let your Peerless Representative give you full details.

PEERLESS MANUFACTURING COMPANY

Walnut Hill Lane at Old Denton Road
P. O. BOX 13165 • DALLAS, TEXAS
Representatives in All Principal Cities

PEERLESS MFG. CO. DALLAS TEXAS

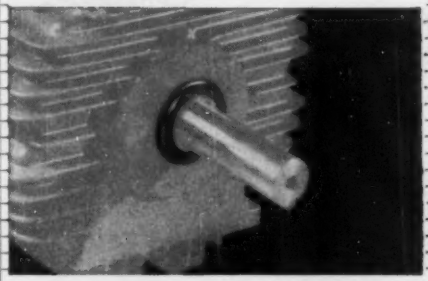


LEGEND OF ABOVE CUTAWAY

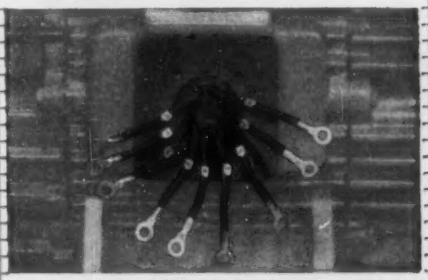
The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

ELLIOTT C-W SEALEDPOWER

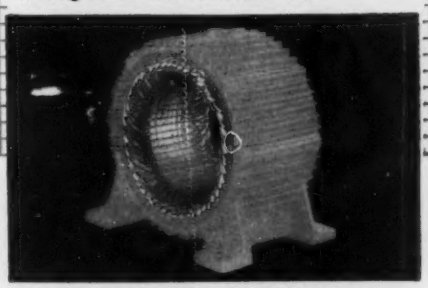
Sturdy external fan has a split hub both keyed to the shaft. No chance of slippage or loosening.



A slinger on the motor shaft effectively guards against the entrance of moisture and foreign material. Slinger is recessed into the bearing bracket to provide a long, labyrinth-type seal.



All leads pass through a grommet as they are brought out of the motor frame. When conduit box is mounted in position, the grommet is tightly compressed, providing a snug seal at this vulnerable area.



Precision-built stators are individually surge tested, and impregnated with siliconized varnish, for improved heat stability and heat resistance.

. . . designed for the dirty jobs

Elliott C-W Sealedpower motors can safely be installed outdoors, or in dusty, moist and corrosive atmospheres. Internal parts are thoroughly protected from the environment. Many users have standardized on this type of motor for all applications because they find that the total cost—first cost plus maintenance—is less for totally-enclosed motors than for conventional enclosures!

This popular, dependable group of motors is part of the Elliott C-W line, which includes also standard Dripproof-protected and Explosion-proof designs.

The original C-W fin-cooled, self-cleaning design which provides more cooling area—no internal passages to clog.

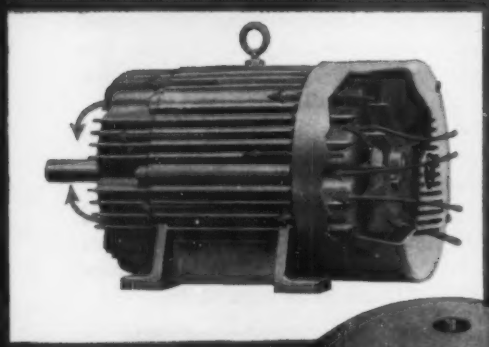
ELLIOTT Company

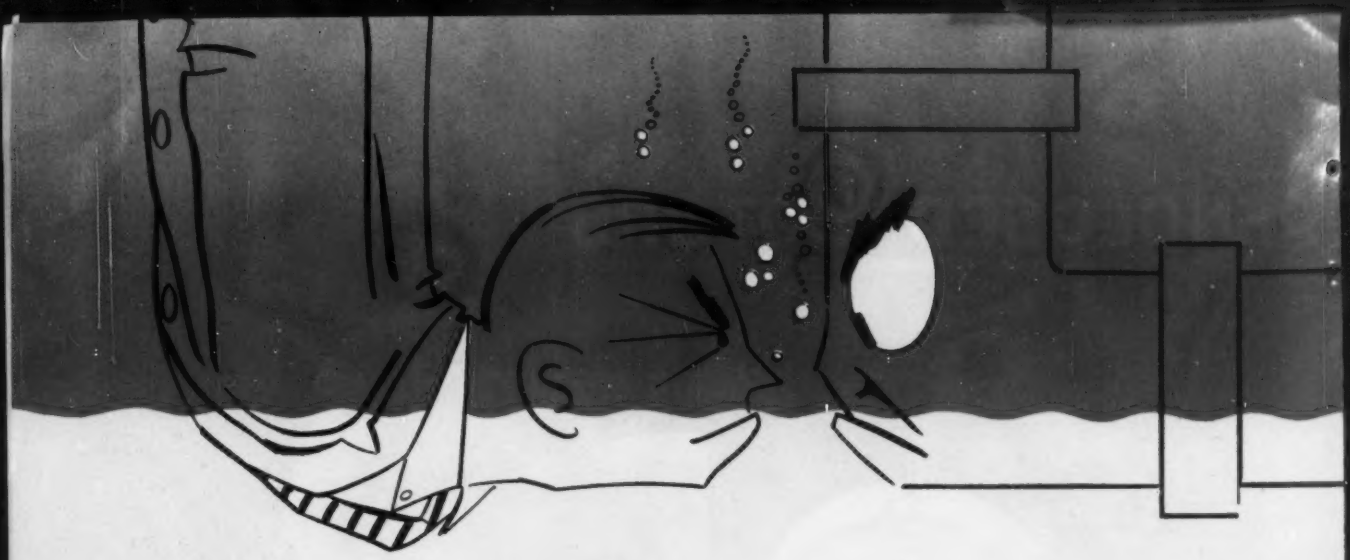
CROCKER-WHEELER PLANT, Jeannette, Pennsylvania

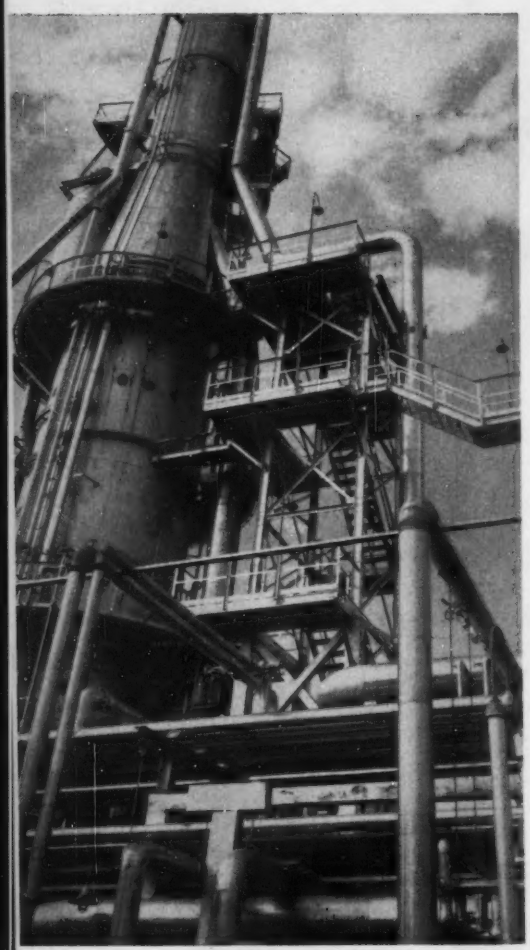
Write for Bulletin PB 6000-6, which describes in detail the features which make Elliott C-W motors outstanding.

WO-2

ENCLOSED MOTORS







You say you have an acid problem?

If your refinery acid problems are so bad that they're creating acid problems in your stomach, maybe you'd better get in touch with National* Tube. We can't give you medical advice, but we can sure straighten out your refinery tubing problems. You see, we *specialize* in finding ways to combat acids, corrosion, high temperatures, high pressures, and oxidation.

Our experience in this field comes from over 60 years of collecting data on the solving of tough refinery tubing problems. We've used this data to develop 24 different steel tube analyses—each one the answer to a specific set of refinery conditions. These analyses have been proved over and over again in actual service.

Besides the 24 analyses shown here, we have other chemical compositions in tubular products available. And we're presently studying a variety of temperature problems.

National Tube's Mill Service Force, available for field consultation, will be happy to help you find the right alloy, at the right price, to meet your needs. Just write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Here are National Tube's two dozen different tube analyses:

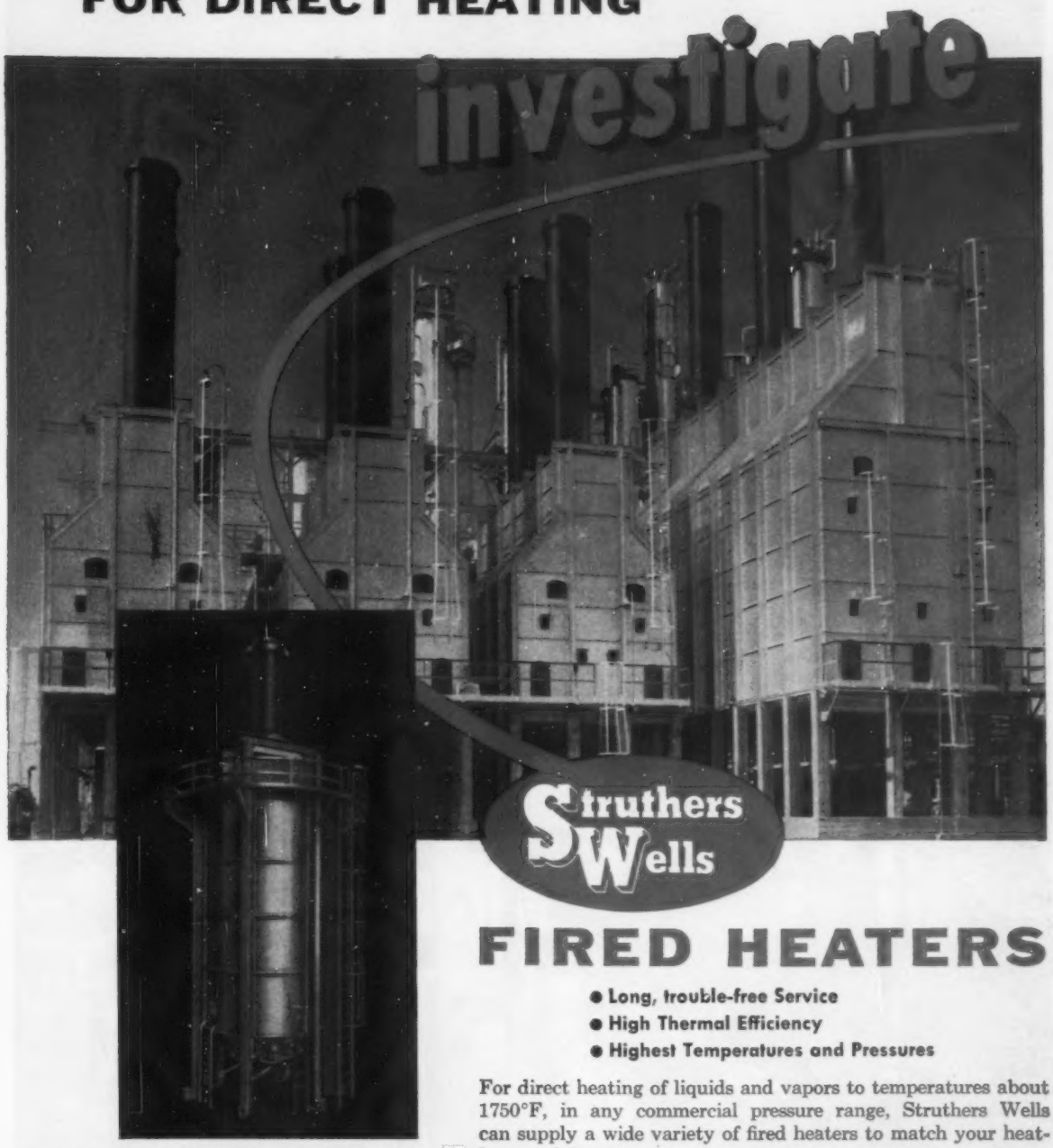
Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8 (18 Cr, 8 Ni)
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti (18 Cr, 8 Ni)
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb (18 Cr, 8 Ni)
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo (18 Cr, 8 Ni)
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20 (25 Cr, 20 Ni)
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni

"The world's largest and most experienced manufacturer of tubular products
NATIONAL TUBE"

National Tube
Division of USS United States Steel
*TRADEMARK

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division
United States Steel Export Company, New York

FOR DIRECT HEATING



FIRED HEATERS

- Long, trouble-free Service
- High Thermal Efficiency
- Highest Temperatures and Pressures

For direct heating of liquids and vapors to temperatures about 1750°F, in any commercial pressure range, Struthers Wells can supply a wide variety of fired heaters to match your heating requirements.

Many units are being supplied to the petroleum and petrochemical industries, for direct heating of oil and hydro-carbon gases, and for cracking service. Equipment is supplied to heat gases to high temperature for chemical plant service, and for thermal and catalytic cracking of chemical compounds.

Heating units and complete systems have been supplied using circulating mediums, to temperatures above 1700°F.

Special heaters supply high temperature water or superheated steam, at high pressures.

Standard designs allow us to make quick quotations and fast deliveries, for most services.

Write on your letterhead for new Bulletin A-46, describing standard heaters.

STRUTHERS WELLS CORPORATION

WARREN, PENNA.

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

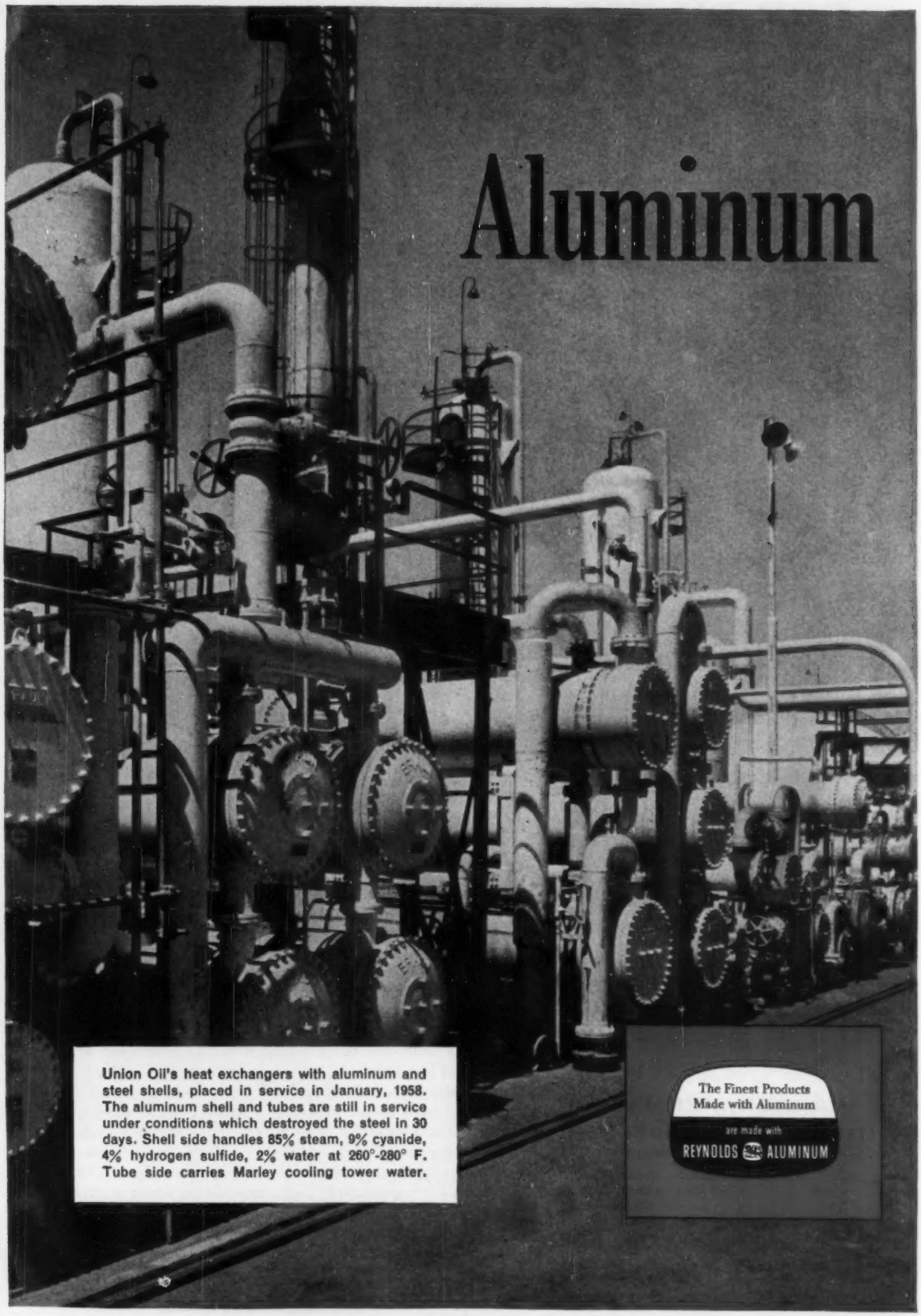
BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

For more data on advertised products, use Readers' Service Cards, last page.


Aluminum
Union Oil's heat exchangers with aluminum and steel shells, placed in service in January, 1958. The aluminum shell and tubes are still in service under conditions which destroyed the steel in 30 days. Shell side handles 85% steam, 9% cyanide, 4% hydrogen sulfide, 2% water at 260°-280° F. Tube side carries Marley cooling tower water.
The Finest Products Made with Aluminum
are made with
REYNOLDS ALUMINUM

Heat Exchangers Last Longer...

up to 7 times longer for Union Oil

Union Oil Company of California is converting several of its shell and tube heat exchangers—and parts of these exchangers—to Reynolds Aluminum. Main reason: aluminum lasts longer in many heat exchanger applications, up to 7 times longer.

For example, in Union's heat exchangers which handle waste water from a refinery cat tower, steel condenser tubes lasted only a few weeks before corrosion made them useless. Aluminum tubes, now in the same service, last 7 times as long handling the same corrosive fluids.

In the same application, steel tube sheet and baffles lasted about 5 months before they had to be replaced. Union engineers replaced these with aluminum and installed aluminum bundles in January, 1957. They are still in service.

The bare tubes of Union's heat exchangers are Reynolds Aluminum alloy 3003-H14, and the tube sheets and baffles are 6061-T6.

Union Oil's aluminum heat exchangers really save in service cost. On a dollars per square foot of heat transfer area per year base, aluminum units are nearly *5 times lower in cost* than the same units with seamless mild steel. This does not include handling costs, which favor lightweight aluminum.

Initial cost, incidentally, is virtually the same for aluminum and steel in these uses.

Heat exchangers are just one of many places Reynolds Aluminum is cutting costs in this industry. Its resistance to corrosion, its passivity, light weight and strength make aluminum *the* logical material for tanks, vessels, jacketing, piping, tubing, and other applications where corrosives must be handled or stored.

To learn how aluminum can cut your costs, write the people who know aluminum and its uses in the chemical and petroleum industry—*Reynolds Metals Company, P.O. Box 2346-CT, Richmond 18, Virginia.* Or contact your local Reynolds branch office, listed under "Aluminum" in the classified phone book.

Write today for Reynolds free bulletins—
"Aluminum for Heat Exchangers" and "Keys to Corrosion".

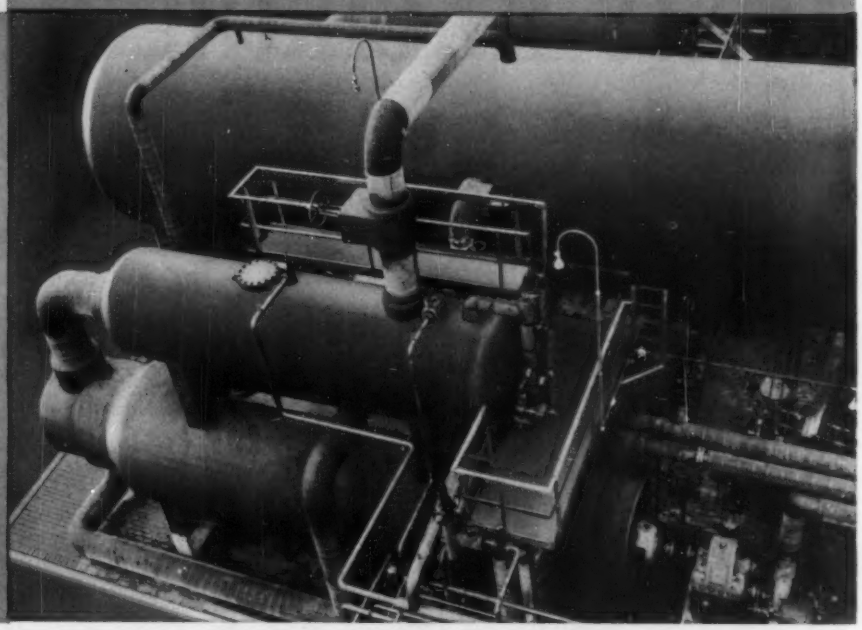
REYNOLDS ALUMINUM

For more data on advertised products, use Readers' Service Cards, last page.

STRATCO
Reg. U.S. Pat. Off.

Effluent Refrigerated ALKYLATION

- Highest Alkylate Quality
- Most Efficient Process
- Easiest to Operate Mechanically
- Most Widely Used



With an Installed Capacity Record That Speaks for Itself

Nearly 50,000 barrels per day of installed capacity indicates how widely Stratco effluent refrigerated alkylation has been accepted by the industry. This record has been made in only six years. It is the result of proved superiority in yield, quality of product and economy of acid consumption, investment and operating costs.

The basis of these advantages is the Stratco horizontal contactor and effluent refrigeration recycle, a combination that makes the Stratco process the most efficient for producing alkylate. It may be used to process propylene, butylene or amylene either separately or as combined streams.

Representatives

D. D. Foster Co., Pittsburgh
Lester Oberholtz, Los Angeles
Rawson-Houlihan Co., Houston
Rawson & Co., Inc., Baton Rouge
F. J. McConnell Co., New York

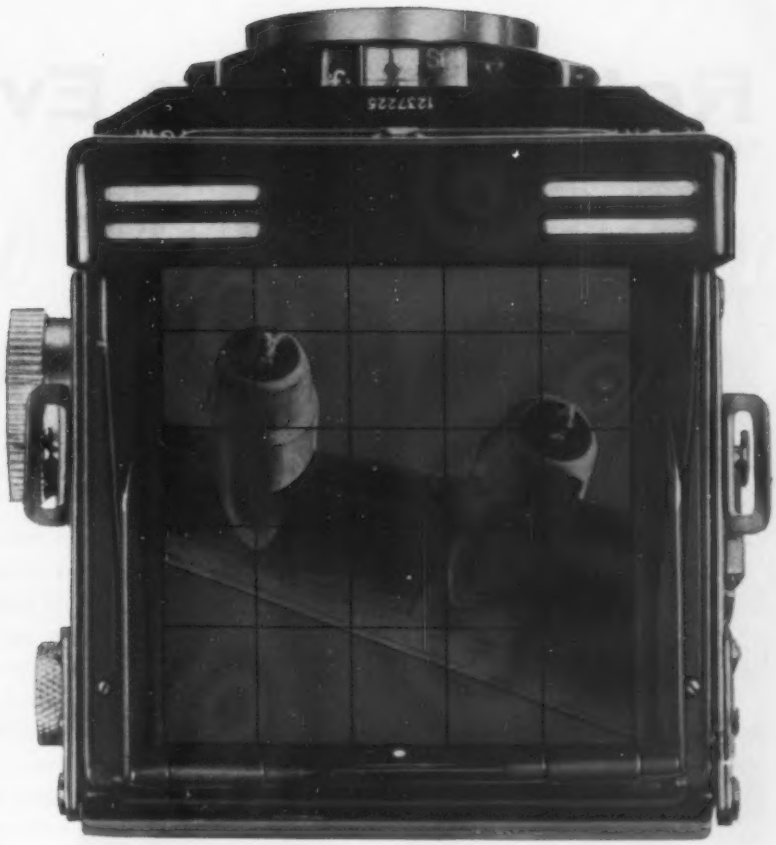
Stratco Effluent Refrigeration licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

Stratco H_2SO_4 Alkylation Units July 1, 1952...July 1, 1958

Location	Approx. Design Cap. BPSD	Units
Texas City, Texas	7500	5**
Watson, Calif.	3000	2*
Amarillo, Texas	950	1
Eagle Point, N. J.	2100	2
Lawrenceville, Ill.	2100	2
Puerto Rico	1400	1
Houston, Texas	6300	4
Hattiesburg, Miss.	2650	2
Toledo, Ohio	1500	1
Beaumont, Texas	7900	5
Sugar Creek, Mo.	3900	2
Kent, England	2500	2
Trenton, Mich.	3600	2
Toledo, Ohio	1500	1
Atreco, Texas	2100	2
Anacortes, Wash.	2400	2
Anacortes, Wash.	2100	2
Formosa	900	1
Houston, Texas	3000	2
Tulsa, Okla.	2400	2

**Closed cycle refrigerated revamp of a 5000 BPSD auto-refrigerated installation.
*Closed cycle refrigerated. All others Stratco effluent refrigerated.
This list does not include 139 units furnished for alkylation service prior to effluent refrigeration development.

STRATFORD ENGINEERING Corporation
612 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.



keep gum formation out of the picture with....

Tenamene

EASTMAN GASOLINE ADDITIVES

Protect the full power you build into your aviation gasolines with gum-inhibiting Tenamene additives.

The Tenamene line includes every principal type of gum inhibitor in commercial use today.

The quality and uniformity of the Tenamene additives are assured since Eastman manufactures all of the gasoline additives it supplies and exercises precise control over every step in the manufacture of them.

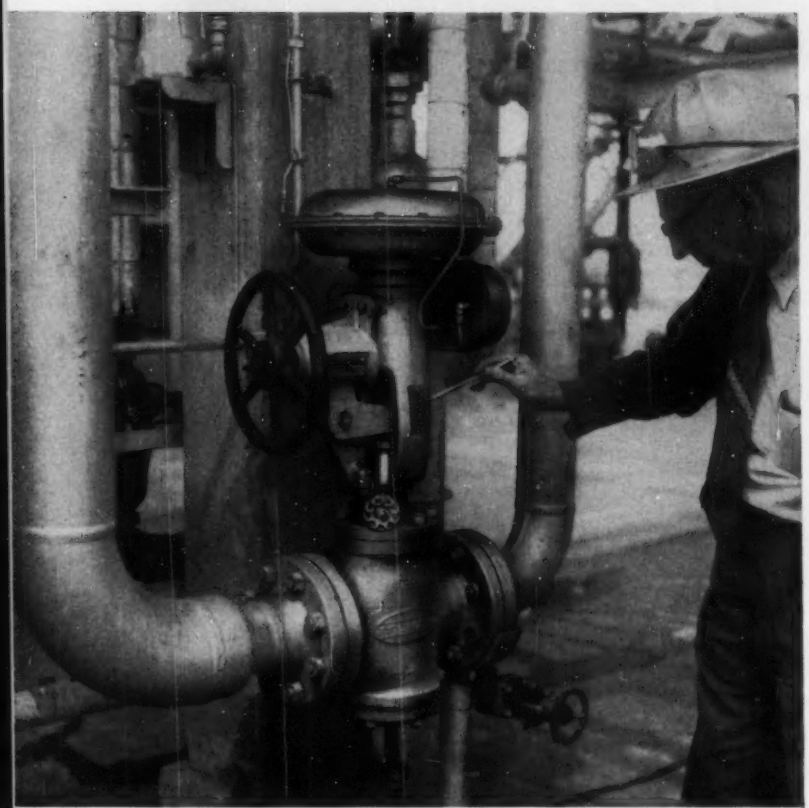
On-the-spot technical service is available from qualified Eastman petroleum specialists to help you achieve maximum performance from these dependable additives.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

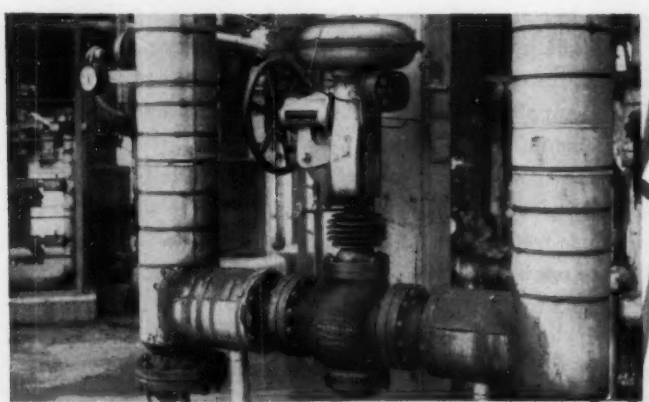
SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston.
West Coast: Wilson Meyer Co., San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

For more data on advertised products, use Readers' Service Cards, last page.

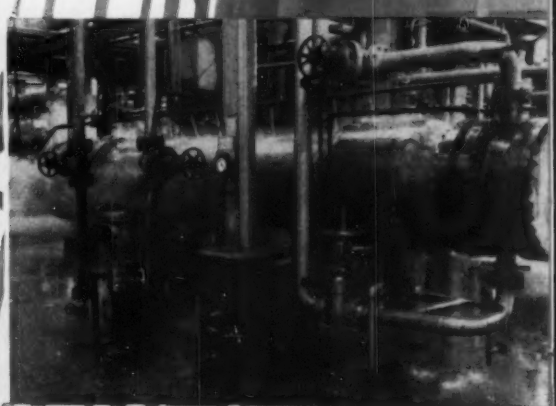
Refinery Men Everywhere



Masoneilan Control Valve w/Positioner and Side-Mounted Handwheel on Alkylation Unit.



Liquid Level Control Valve on Feed Line to Heaters in a Sovaformer Unit.



Liquid Level Control Valve on a Heat Exchanger in Sovaformer Unit.

Say—

"We know M-N Equipment is Dependable!"

Where quality of product depends upon quality of equipment, it's a better-than-even bet that the controls include one or more items from the Masoneilan line.

Pictured here are representative Masoneilan controls at work in a modern refinery, where Sovaformer and Alkylation processes are used to produce high octane premium gasoline. Quality must be rigidly controlled. Only dependable, accurate valves and controllers can meet requirements. Here, as in other refineries all over the world, operating men say "Masoneilan equipment has proved to be dependable; we are confident in using it."

The Masoneilan line offers a wide variety of equipment on which you can depend. Take the first step toward becoming acquainted with Masoneilan Controls — write for catalog.

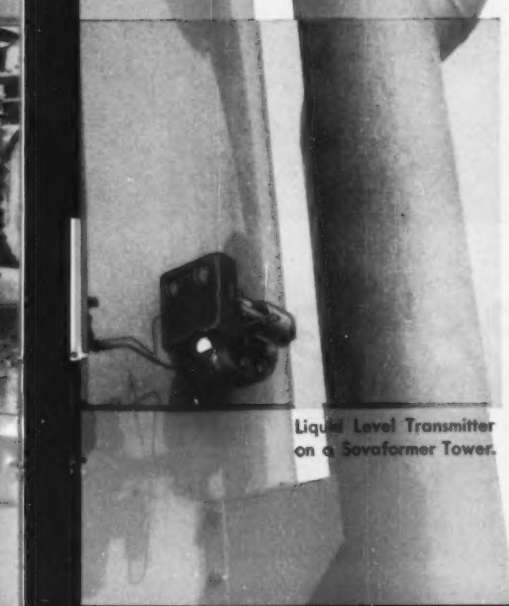
MASON-NEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASS.

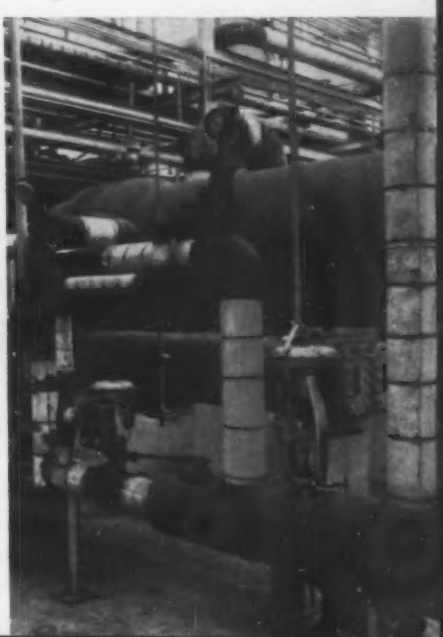
Major Product Lines Available from Mason-Neilan

- Control Valves • Liquid Level Controls
- Pneumatic Controllers
- Pressure Regulating Valves
- Temperature and Pressure Transmitters.



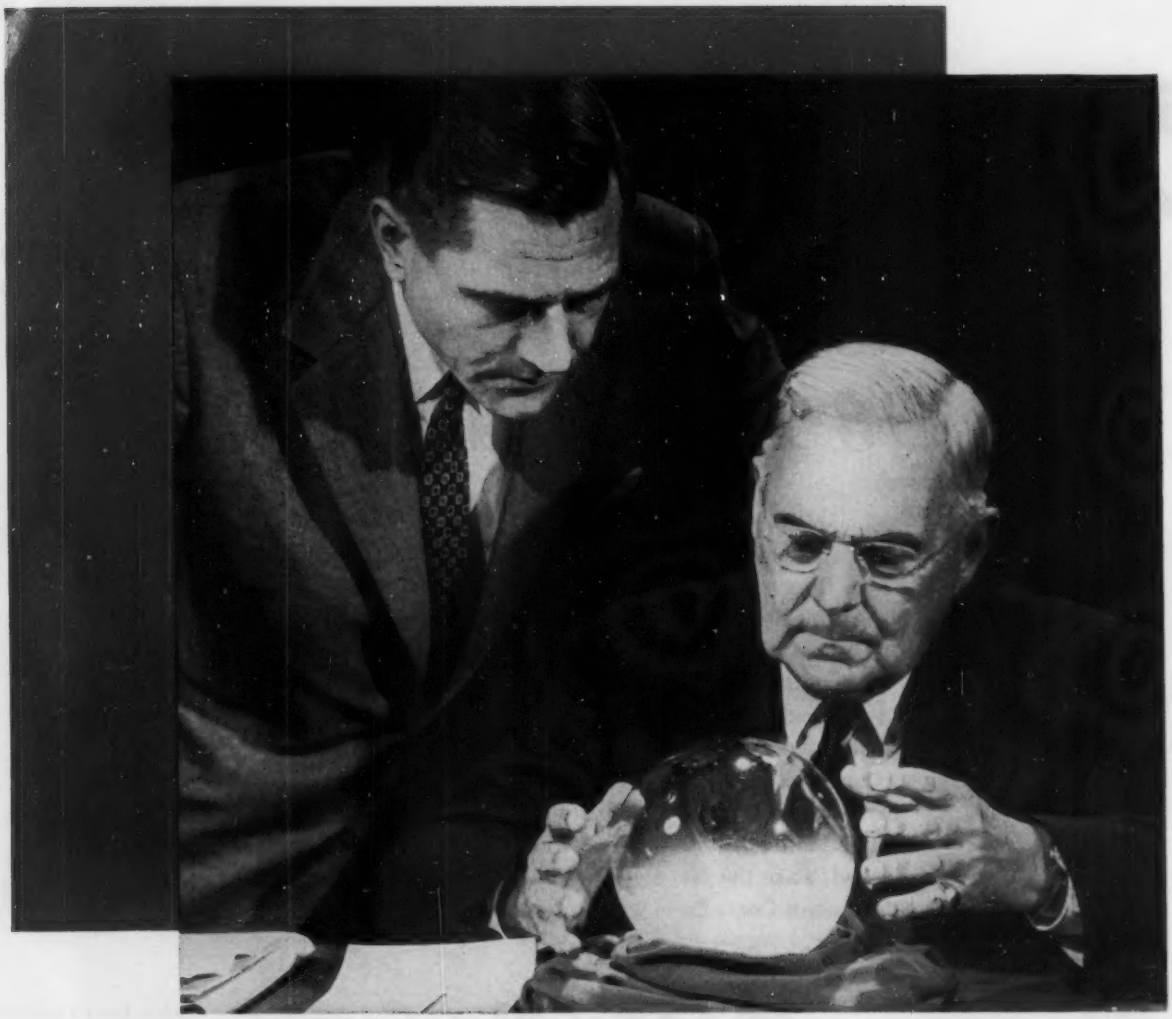
Liquid Level Transmitter on a Sovaformer Tower.

Operator Checks Control Valve on Heavy Naphtha Line to Absorber.



Left—Valve Controlling Fuel Gas Pressure.

Right — Emergency Shutoff Valve.



Wishful thinking never assures true economy in industrial construction—especially in the fabrication and erection of critical piping. Big power and processing plants have proved again and again the soundness of delegating high-temperature, high-pressure jobs directly to specialists... So, ask us in.

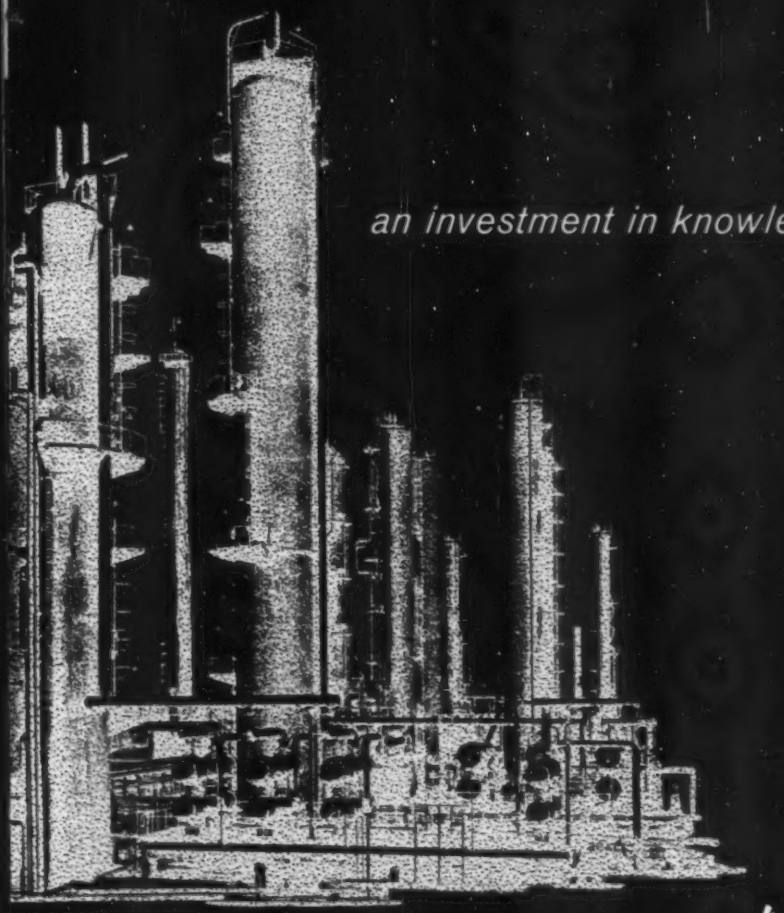
W. K. MITCHELL & CO., INC.

Philadelphia 46, Pa.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS



*an investment in knowledge pays the best interest **

* BENJAMIN FRANKLIN

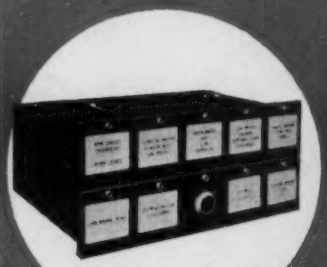
TELLEPSEN PETRO-CHEM
CONSTRUCTORS

A Division of Tellepsen Construction Company

P. O. BOX 2536 · HOUSTON, TEXAS · TELETYPE HO-101 · CABLE — "Tellecon"

MEXICO: Tellepsen de Mexico, S.A. de C.V. — Mexico, D.F. · VENEZUELA: Trans-Caribbean, S.A. — Maracaibo, Ven.

ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM, CHEMICAL AND PETRO-CHEMICAL INDUSTRIES ANYWHERE IN THE WORLD



SCAM DE-LINE

Building-block principle plus all desired alarms and sequences give this system extreme flexibility.

SCAM DE-LINE provides maximum flexibility. Widely used in the Power Industry . . . Central Generating Systems.

Controls and alarms for every requirement!

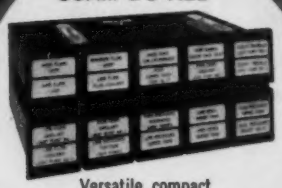
SCAMMIT-STATIC SWITCHING

Monitoring systems for process and automation control . . . no moving parts.

proved reliability
low initial cost
complete design flexibility

Regardless of the operation or process you wish to control or the alarm network you need to set up, SCAM INDUSTRIAL MONITORING SYSTEMS will meet your requirements with remarkable efficiency and reliability. Modular components and construction for most applications; custom units for special situations.

SCAM DU-ALL

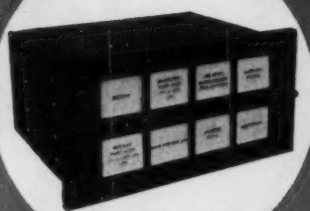


Versatile, compact, self-contained . . . more alarm with fewer components.

SCAM® INDUSTRIAL MONITORING SYSTEMS

WRITE TODAY . . . for complete information and literature

Complete Monitoring Systems for Industry



SCAM S-LINE

Wide variety of combinations, yet standardized for general purpose needs.

SCAM EXPLOSION-PROOF

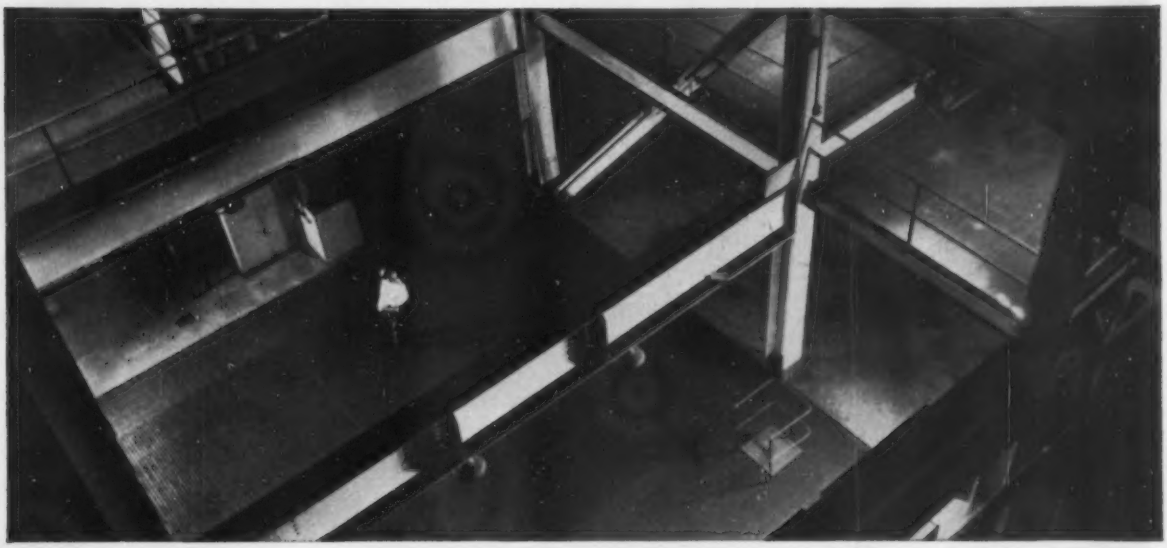
Systems designed for safe use in potentially hazardous atmospheres.

SCAM INSTRUMENT CORPORATION

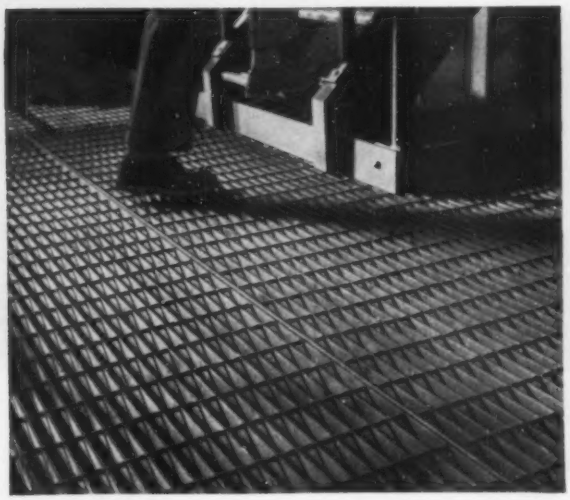
1813 West Irving Park Road • Chicago 13, Illinois
Telephone: GRaceland 7-7850

REPRESENTATIVES IN ALL PRINCIPAL CITIES

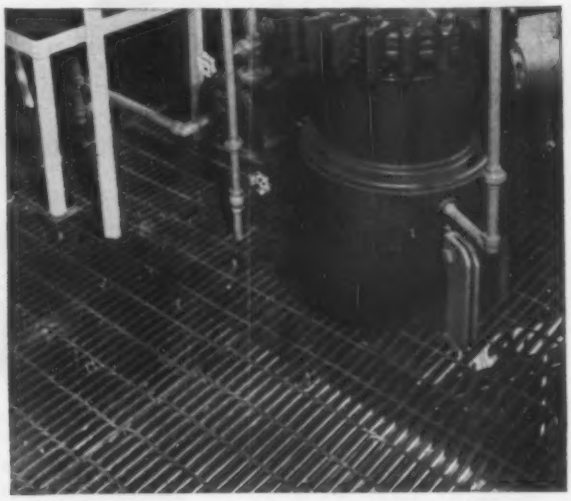
designed for flexibility...**Electroforged® for strength**
Blaw-Knox Grating fits modern plant needs



More floor space . . . Platforms, mezzanines and loading docks made of flexible Blaw-Knox Electroforged Steel Grating increase storage space, enlarge feeder areas. Easily installed, and easily adapted to changing layouts.



Safer walking . . . on *non-slip* floors, walkways and stairs, Blaw-Knox Electroforged Steel Grating provides rigid one-piece construction and features the twisted cross bar to make every step a safe step.



Fits anywhere . . . around pipes, beams and machinery to provide a neat, easy-to-maintain surface. There's nothing to wear, patch or catch dirt. And Blaw-Knox Grating admits more light and air for ideal working conditions.

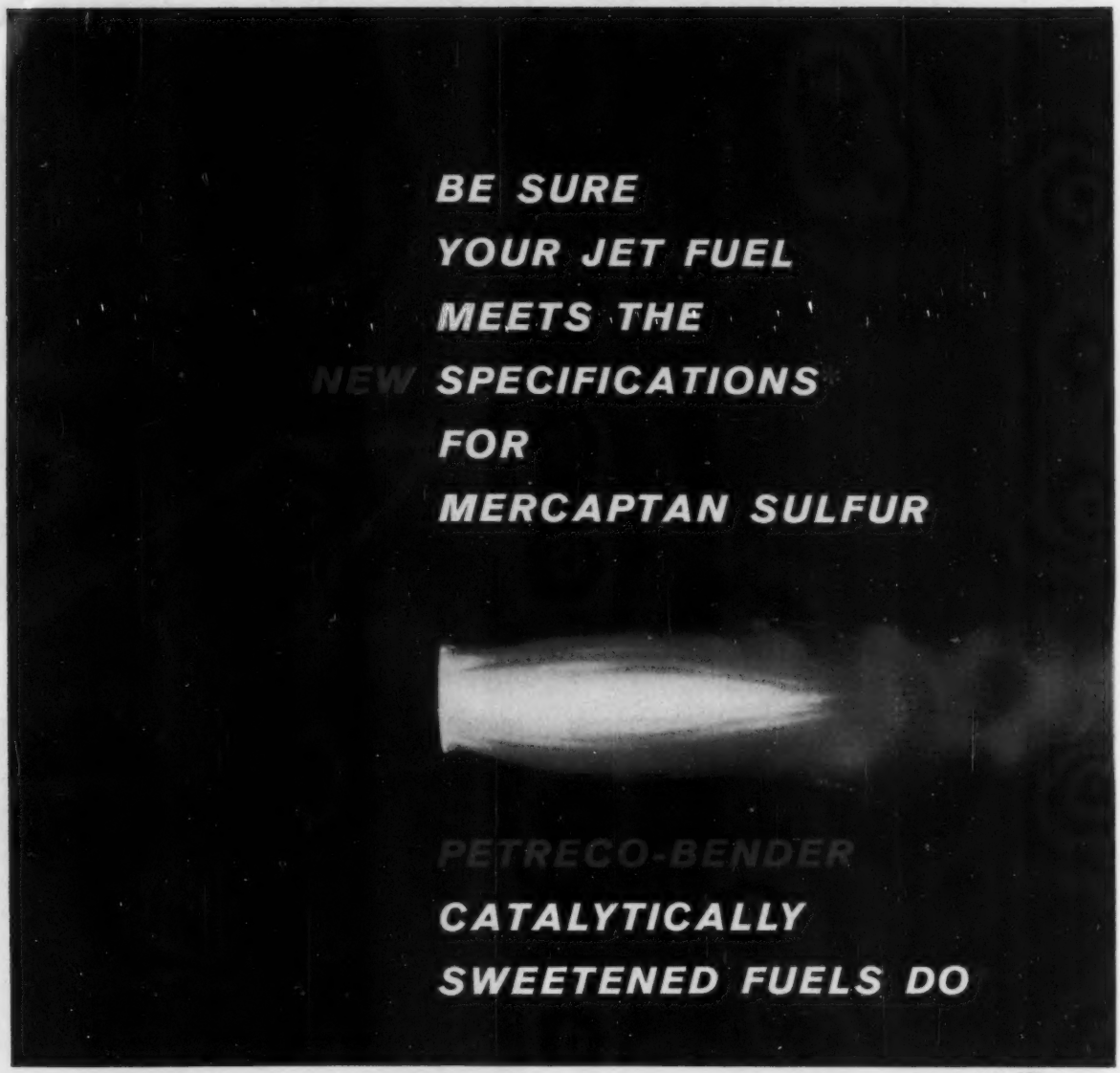
Write for Bulletin 2527 and see how Blaw-Knox Grating can be custom fabricated to meet your plant improvement specifications.

BLAW-KNOX

BLAW-KNOX COMPANY

Equipment Division
Department D, Pittsburgh 38, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.



	Wt. / %
* Former Mercaptan Sulfur Tolerance	0.005
New Mercaptan Sulfur Tolerance	0.001

PETRECO-BENDER SWEETENING CONSISTENTLY YIELDS "DOCTOR" SWEET "NON-CORROSIVE" PRODUCTS

The Petreco-Bender Sweetening Process sweetens middle range distillates at an operating cost of 0.5 to 1.0 cents per barrel lower than conventional sweetening processes. The capital investment is low (about one-tenth that of hydrotreating). Get all the facts today. Just call or write . . .

PETRECO

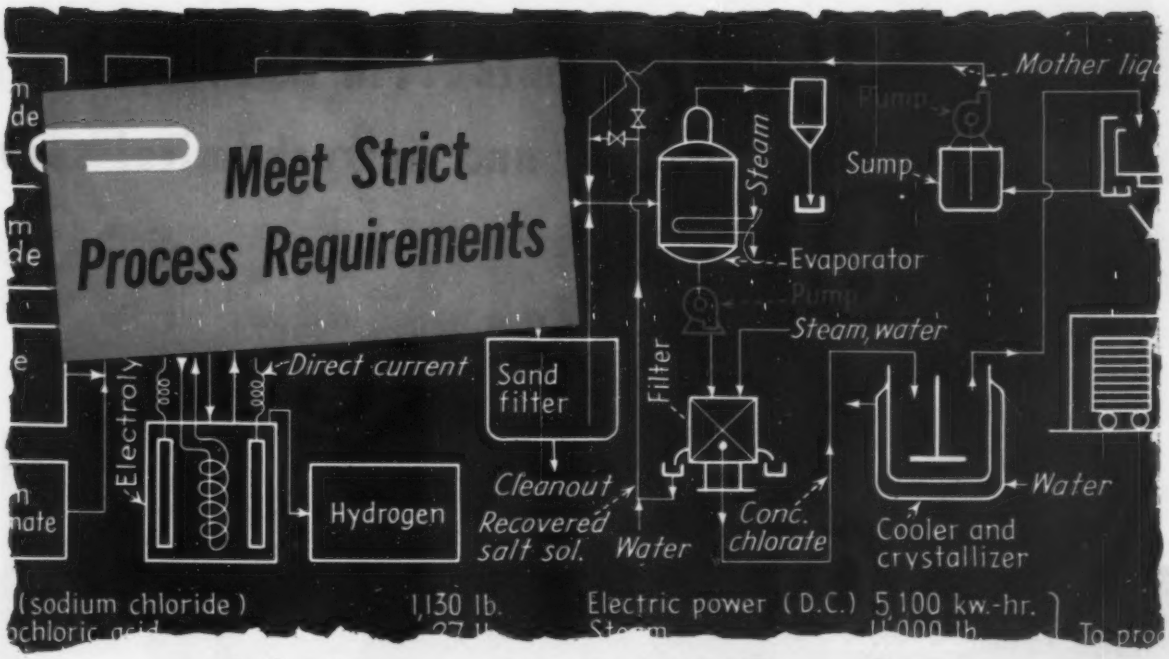
A DIVISION OF PETROLITE CORPORATION

3202 So. Wayside Drive, Box 2546, Houston 1, Texas
1390 E. Burnett Street, Box 7216, Long Beach 7, Calif.

Specialized Petroleum Treating Processes and Equipment

DESALTING • DEHYDRATION • DISTILLATE TREATING • SWEETENING
LUBE OIL TREATING • SEDIMENT REMOVAL

B-58-2



. . . with Eastern Centrifugal Pumps

Models 2F and 2J
to 2 g.p.m., 25-42 p.s.i.

Model D-11
to 7.5 g.p.m., to 18 p.s.i.

Model F
to 17 g.p.m., to 17 p.s.i.

Models U-17 and U-34
to 38 g.p.m., to 21 p.s.i.

Models W and Z
to 70 g.p.m., to 11 p.s.i.

Models 3F and 3J
to 5 g.p.m., 29-65 p.s.i.

Recent redesign of these close-coupled Centrifugal Pumps has gained tremendous ruggedness and allowed for a wide selection of power requirements. In every detail of size, weight, space requirements, power, and costs, Eastern pumps fill the bill for strict process standards.

Six standard models range from 1/8th to 3/4 H.P., with capacities up to 70 G.P.M., pressures to 65 P.S.I. Eastern Centrifugal Pumps are available in Cast Iron, Bronze, Stainless Steel, Monel, and Hastelloy "C".

Eastern's engineering service offers many special models to meet your specific needs as to capacity and construction. Recommendations entail no obligation, and your inquiries are invited.

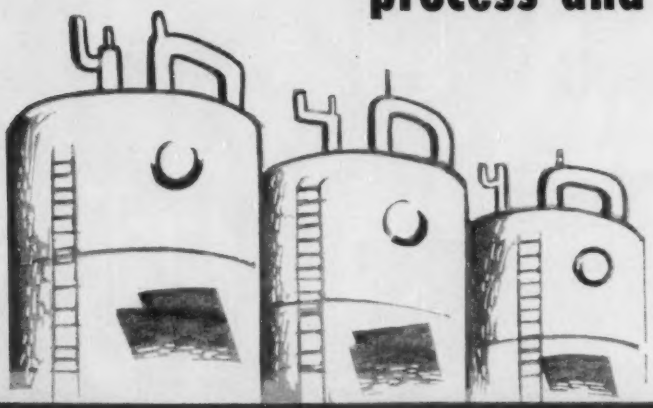
NEW EASTERN CATALOG

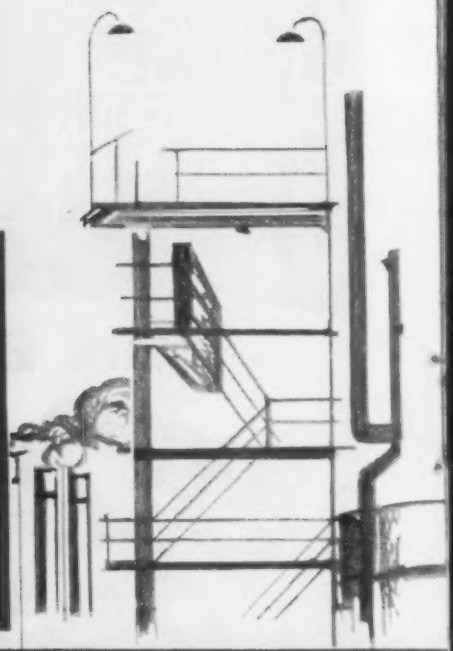
Eastern Centrifugal Pump Catalog contains engineering data, performance charts, diagrams and helpful general information. Request Bulletin 110 G.

Eastern
INDUSTRIES, INC.
100 SKIFF ST.
HAMDEN 14, CONN.

For more data on advertised products, use Readers' Service Cards, last page.

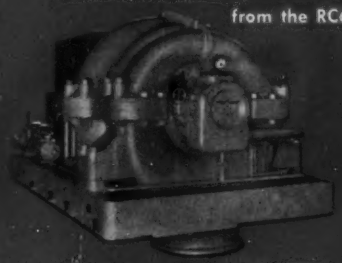
Whatever your requirements . . . in refinery, process and petrochemical service

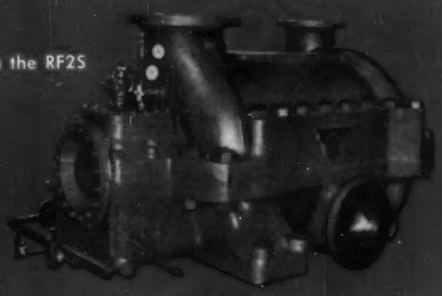




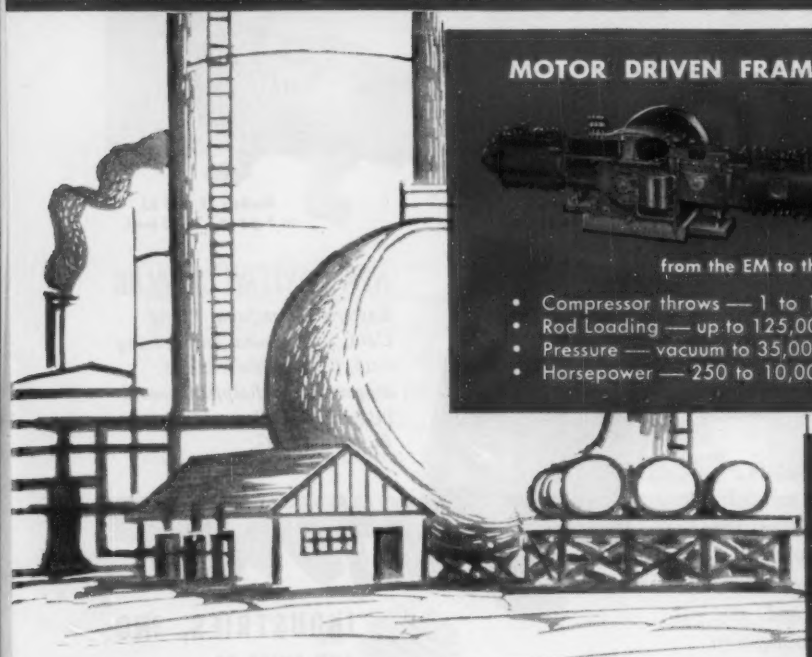
CENTRIFUGALS

from the RC6S to the RF2S

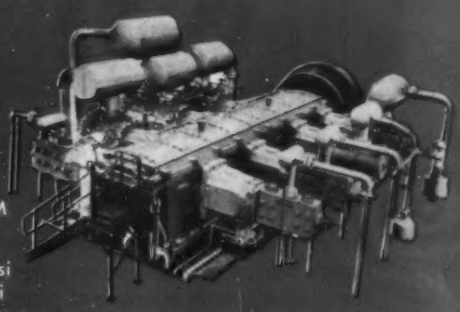




- Pressure — vacuum to 5000 psi
- Horsepower — 1000 to 15,000 hp



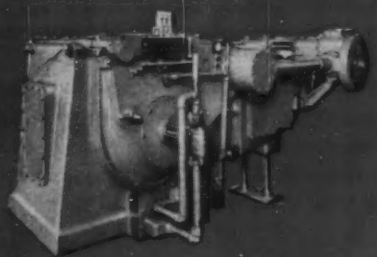
MOTOR DRIVEN FRAMES



from the EM to the LM

- Compressor throws — 1 to 10
- Rod Loading — up to 125,000 psi
- Pressure — vacuum to 35,000 psi
- Horsepower — 250 to 10,000 hp

EXPANDER UNITS



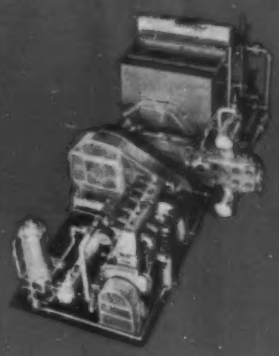
from the JX to the FX

- Pressure — to 3000 psi

THERE'S THE RIGHT COOPER-BESSEMER

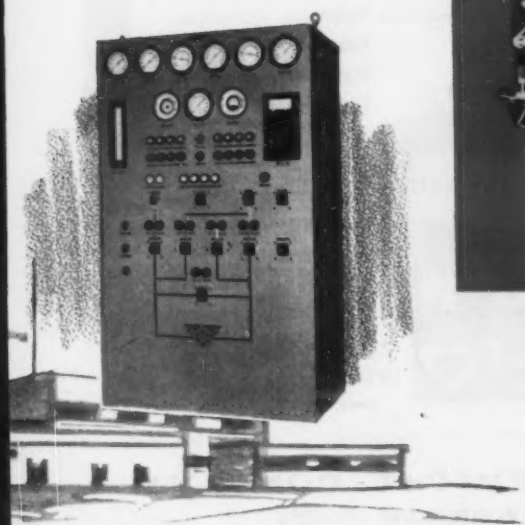
for top efficiency • economy • flexibility

ENGINE DRIVEN FRAMES

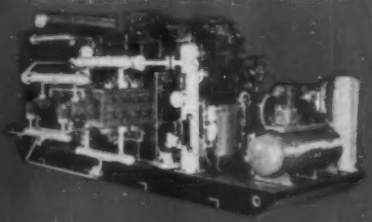


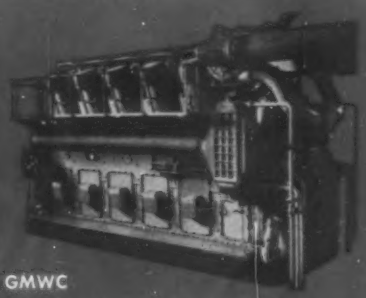
from the FMP to the LSV-driven JM

- Compressor throws — 1 to 10
- Rod loading — up to 125,000 psi
- Pressure — vacuum to 35,000 psi
- Horsepower — 500 to 5000 hp



INTEGRAL ANGLE UNITS





from the GMXD to the GMWC

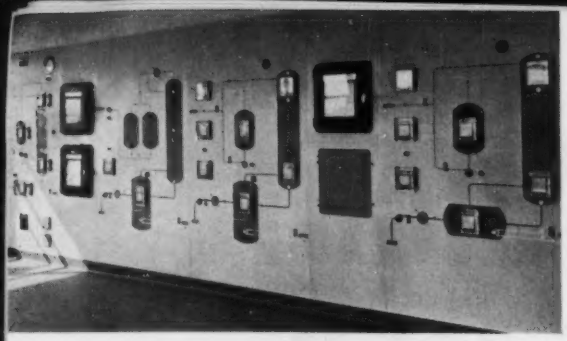
- Pressure — vacuum to 35,000
- Horsepower — 265 to 3500 hp

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas
Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis • New Orleans • Shreveport
SUBSIDIARIES: COOPER-BESSEMER OF CANADA, LTD.... Edmonton • Calgary • Toronto • Halifax
COOPER-BESSEMER INTERNATIONAL CORPORATION... New York • Caracas • Mexico City



The facilities and experience of Truland may be employed advantageously for the economical upgrading and disposal of solvent mixtures and organic by-products.
Our technically trained personnel are available to discuss the refining of any solvent mixture or organic by-product.

REFINING OF YOUR BY-PRODUCTS

Partial List
of materials processed

- Acetone
- Amyl Acetate
- Amyl Alcohol
- Benzene
- n-Butyl Acetate
- n-Butyl Alcohol
- Butyl Cresols
- Butylene Glycol
- Capryl Alcohol
- Carbon Tetrachloride
- Chlorbenzene
- Chloroform
- Dibutyl Phenol
- Dibutyl Phthalate
- Dicapryl Phthalate
- o-Dichlorbenzene
- Diethanolamine
- Diethylene Glycol
- Dimethyl Phthalate
- Dimethyl Sebacate
- Dipropylene Glycol
- Dodecyl Alcohol
- Dodecylbenzene
- Ethyl Acetate
- Ethylene Dichloride
- Ethylene Glycol
- Ethyl Hexanediol
- Ethyl Lactate
- Glycerine
- Glycol Ethers
- Hexyl Alcohol
- Isobutyl Alcohol
- Isodecyl Alcohol
- Isooctyl Alcohol
- Isophorone
- Isopropyl Acetate
- Isopropyl Alcohol
- Methyl Alcohol
- Methyl Amyl Alcohol
- Methylene Chloride
- Methyl Ethyl Ketone
- Methyl Hexyl Ketone
- Methyl Isobutyl Ketone
- Monoethanolamine
- Naphthas
- Nitrotoluols
- Nonyl Phenol
- Octyl Acetate
- Perchlorethylene
- n-Propyl Alcohol
- Propylene Glycol
- Pyridine
- Toluene
- Trichlorbenzene
- Trichlorethylene
- Tricresyl Phosphate
- Triethyl Amine
- Triethylene Glycol
- Trimethyl Borate
- Vinyl Acetate
- Xylene

Send *for new booklet which describes our operation*

TRULAND

TRULAND CHEMICAL COMPANY
EAST RUTHERFORD, NEW JERSEY

DIVISION OF THE TRUBEK LABORATORIES

HOWE-BAKER ENGINEERS, INC.

HOWE - BAKER ELECTRICAL PROCESSES

DESALTING

DESCRIPTION: Process to remove salt and other impurities from crude being charged to distillation equipment.

EQUIPMENT: Electrical equipment in desalting vessel; power supply, instrumentation, etc.

ECONOMIC CREDITS: Economic studies show payouts will vary from low of 100% a year to a high of 250% a year. *Minimum* credits accruing to refiner from its use: 4.6c/bbl., through increased capacity; 1.1c/bbl., through reduced maintenance; 1.6c/bbl., through improved catalytic and thermal cracking operations; 0.6c/bbl., through reduced corrosion damage; 0.2c/bbl., through increased tank capacity. Total credits: 8.1c per barrel of crude charged.

PROVED: Over 1.7 million barrels of crude oil per day are being treated by electrostatic desalting units designed by Howe-Baker.

DISTILLATE TREATING

DESCRIPTION: Process to remove treating agent (such as acid, caustic or water) from petroleum distillates.

EQUIPMENT: Electrical equipment in conventional treating vessel; power supply, instrumentation, etc. Frequently, electrical equipment can be installed in existing vessel.

EFFICIENT: Fully automatic and continuous, electrical precipitation drastically reduces carry-over of addition agent . . . lowers chemical consumption . . . eliminates many disadvantages of batch settling.

PROVED: Acceptance by refiners all over the world has been very rapid—over *1 million* BPD capacity of commercial units sold—an additional 2.5 million BPD under consideration. Send for Howe-Baker's new distillate treating report.

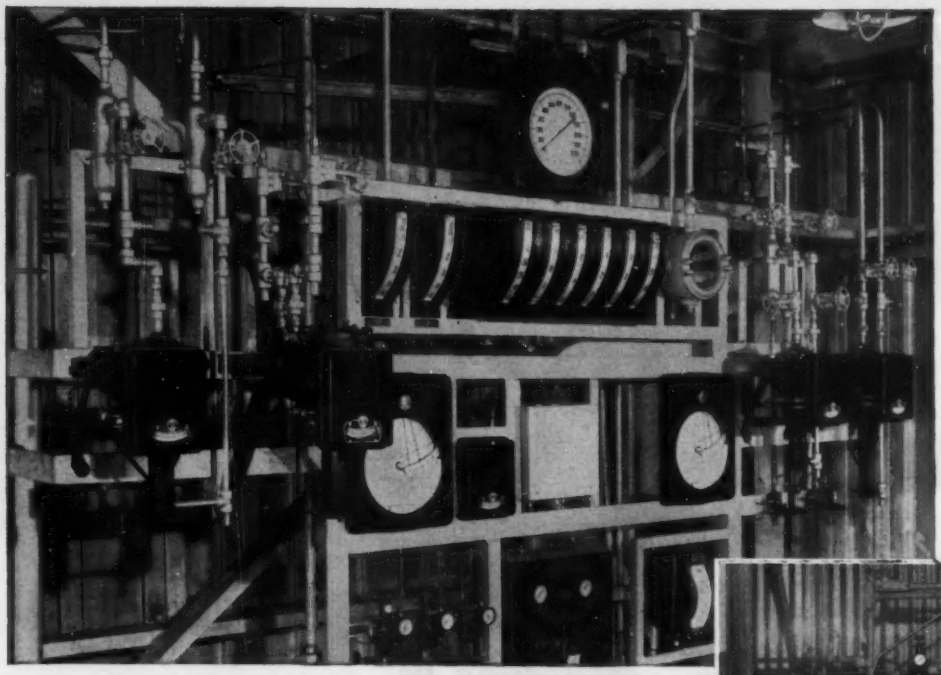
AT YOUR REQUEST, by telephone or mail, a Howe-Baker representative will visit your plant at your convenience to discuss your particular problem with you. He will thoroughly explain equipment and services furnished, guarantees and operating conditions. Without obligation, of course.

HOWE-BAKER ENGINEERS, INC.

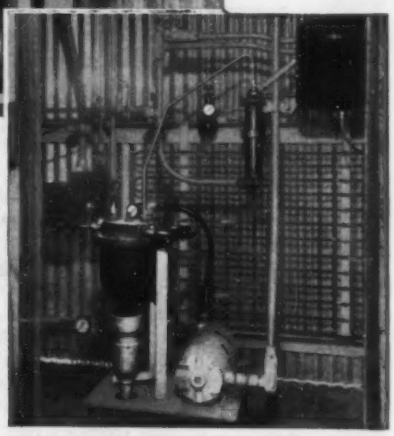
EASTERN DIVISION:
35 LEONARD DRIVE • WESTWOOD, NEW JERSEY

SOUTH AMERICAN REPRESENTATIVE:
ACHABE, S.A. • APARTADO 4668, CHACAO • CARACAS, VENEZUELA

TYLER, TEXAS



These Bailey Pneumatic Transmitters on CO boiler at Tidewater measure and transmit: Fuel gas flow, drum level, per cent oxygen, steam pressure, furnace temperature, CO gas flow, steam flow, duct and furnace pressures. Other Bailey transmitters (not shown) measure feed water flow, oil flow, air flow, and steam temperatures.



Bailey Gas Analyzer for oxygen and combustibles in flue gas.

Bailey Control for CO Boiler at Tidewater...

Bailey Instruments and Controls help Tidewater Oil Company to secure design performance from the new carbon monoxide boiler in its Delaware Refinery. The Bailey Equipment here is of the pneumatic transmission type operating on a standard 3-15 psi signal range. This allows a wide selection of receiving instruments for control room service.

Bailey Controls on the CO Boiler function to maintain:

1. Steam Pressure
2. Steam Temperature
3. Elevated Furnace Temperature for combustion of CO
4. Optimum fuel-air ratio for all mixtures of CO and supplementary fuels
5. Safe water level in boiler drum
6. Proper differential between pressures in boiler drum and at feed water pump outlet
7. Circulation through boiler feed pumps.

For combustion "know-how" with standardized instrument and control components, see your local Bailey Engineer or call our headquarters at Cleveland.

CP2-1

BAILEY BUILDING BLOCK METHOD

BAILEY METER COMPANY

CHEMICAL AND PETROLEUM DIVISION

1043 IVANHOE ROAD, CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

Don't pay today's prices for yesterday's engines!

Read on following pages how the new Worthington SLHC engine compressor can substantially reduce your gas handling costs

Only SLHC Turbocharged Gas-
Worthington offers all these

MODERN DESIGN

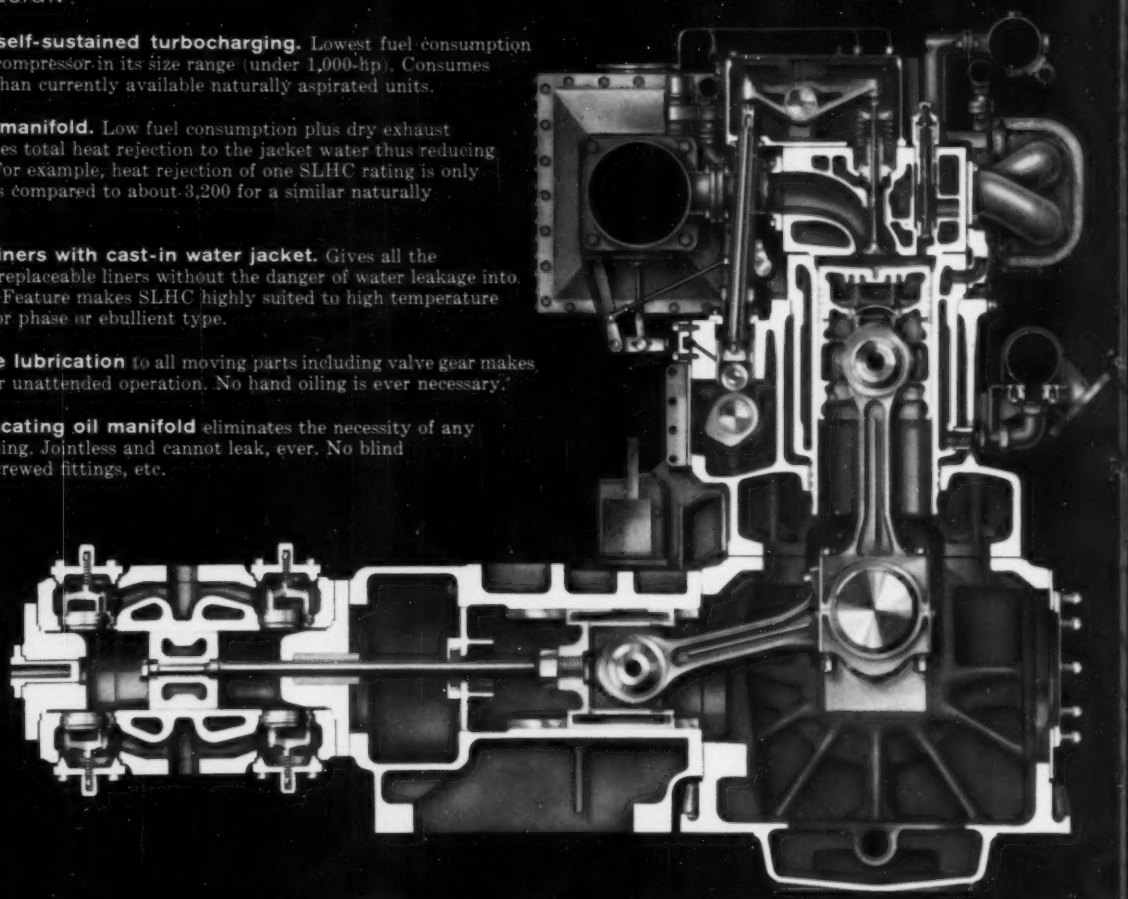
Completely self-sustained turbocharging. Lowest fuel consumption of any engine compressor in its size range (under 1,000-hp). Consumes 20% less fuel than currently available naturally aspirated units.

Dry exhaust manifold. Low fuel consumption plus dry exhaust manifold reduces total heat rejection to the jacket water thus reducing radiator size. For example, heat rejection of one SLHC rating is only 2,015 BTU's as compared to about 3,200 for a similar naturally aspirated unit.

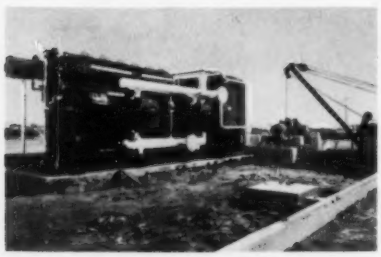
Removable liners with cast-in water jacket. Gives all the advantages of replaceable liners without the danger of water leakage into the crankcase. Feature makes SLHC highly suited to high temperature cooling of vapor phase or ebullient type.

Full pressure lubrication to all moving parts including valve gear makes SLHC ideal for unattended operation. No hand oiling is ever necessary.

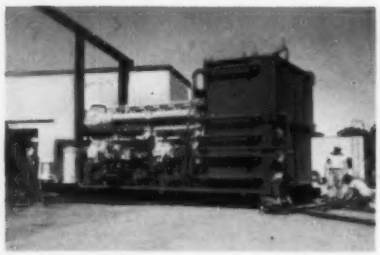
Cast-in lubricating oil manifold eliminates the necessity of any internal plumbing. Jointless and cannot leak, ever. No blind connections, screwed fittings, etc.



Six-cylinder SLHC unit installed by Northern Natural Gas Co. in the Oklahoma Panhandle.



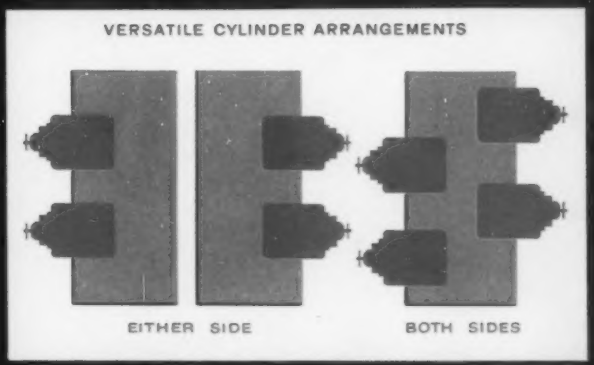
One of three 6-cylinder skid-packaged SLHC units being prepared for shipment to Bolivia, S. A.



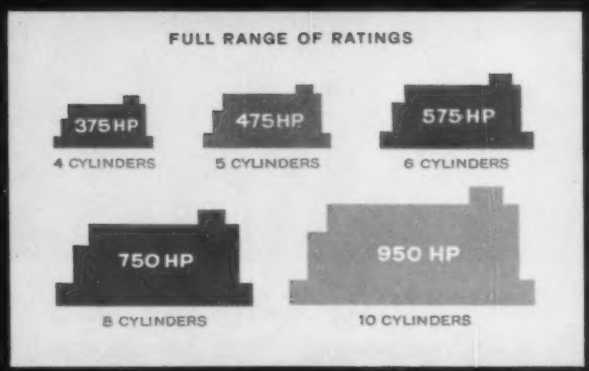
Six-cylinder skid-packaged SLHC unit for service in a Louisiana gas field.

Engine Compressor by modern, dollar-saving features

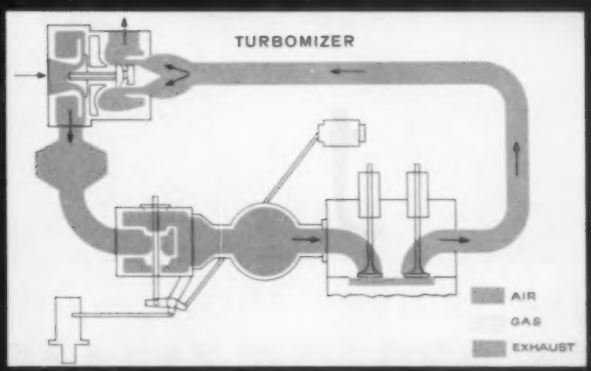
The SLHC will give you about 20% better fuel economy than currently available naturally aspirated units. This chart shows the savings per year for each 1000 hp of continuous operation on natural gas.



Piping and construction problems can be greatly simplified thanks to versatility of cylinder arrangements on SLHC. Cylinders can be mounted on either or both sides. If mounted on both sides, SLHC permits twice as many cylinders as most engine compressors in its size range.

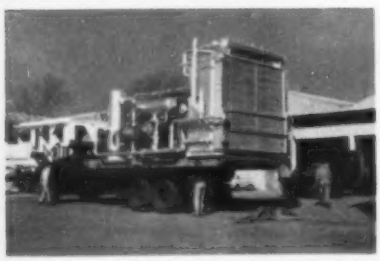


These are the range of ratings offered in the SLHC. Note that all units operate at the conservative speed of 450 rpm with a conservative bmep of under 135 psi. All units may be skid "packaged" —including the 950 hp rating, the largest available for this type service.

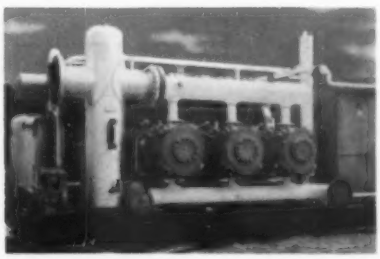


Worthington's Turbomizer is the simplest fuel control system on the market. It offers remarkably favorable fuel consumption and stable operation over the complete load and speed range. Allows operator to compensate for different fuels and heating values in one adjustment.

One of two 4-cylinder SLHC engine compressors to be installed by Permian Basin Pipeline Co. in Lea County, N. M.

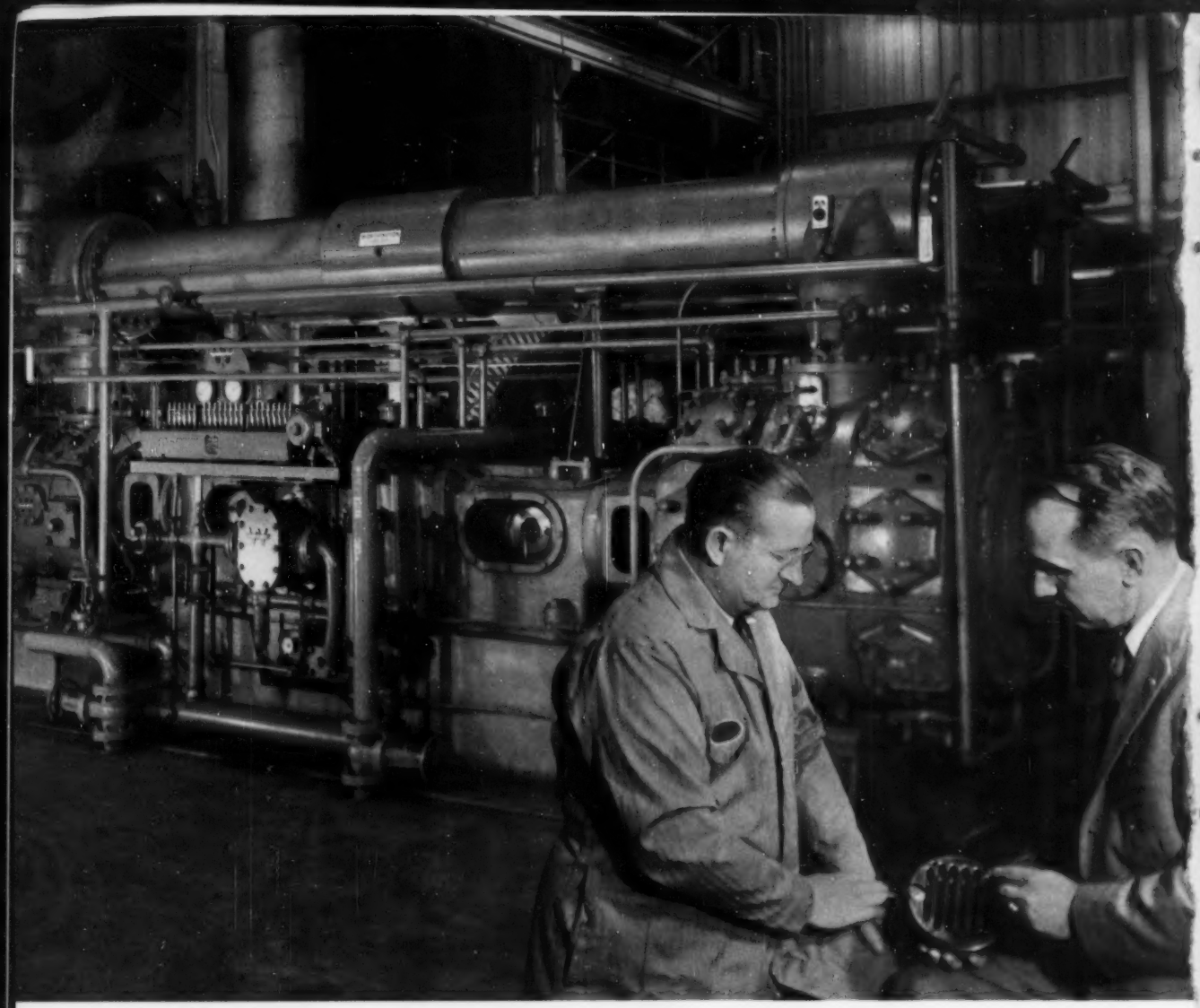


Six-cylinder skid-packaged SLHC gas-engine compressor for a Texas natural gasoline pant.



For complete details, get in touch with your nearest Worthington district office. Or write to Worthington Corporation, Section 43-1, Harrison, N. J. In Canada: Worthington Canada Ltd., Brantford, Ont.

WORTHINGTON



User-survey shows – in all operating categories

FEATHER VALVE VOTED BEST

Simplest Construction:

FEATHER VALVE

VALVE A

VALVE B

Most Efficient:

FEATHER VALVE

VALVE A

VALVE B

Lowest Maintenance:

FEATHER VALVE

VALVE A

VALVE B

Quietest:

FEATHER VALVE

VALVE A

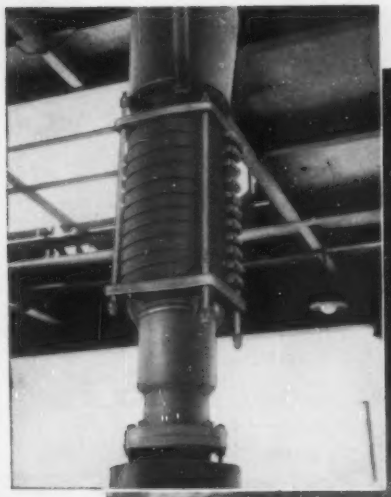
VALVE B

A recent survey among compressor users showed this marked preference in all four operating categories for the amazing Feather* Valve. The Worthington Feather Valve is the lightest, fastest-acting compressor valve available. Because of its lightness and flexibility it provides very sharp action with virtually no slip or back-flow. And because it works with no impact . . . has no buffer plates or cushioning devices . . . it is all but indestructible, assures long-life with negligible maintenance costs.

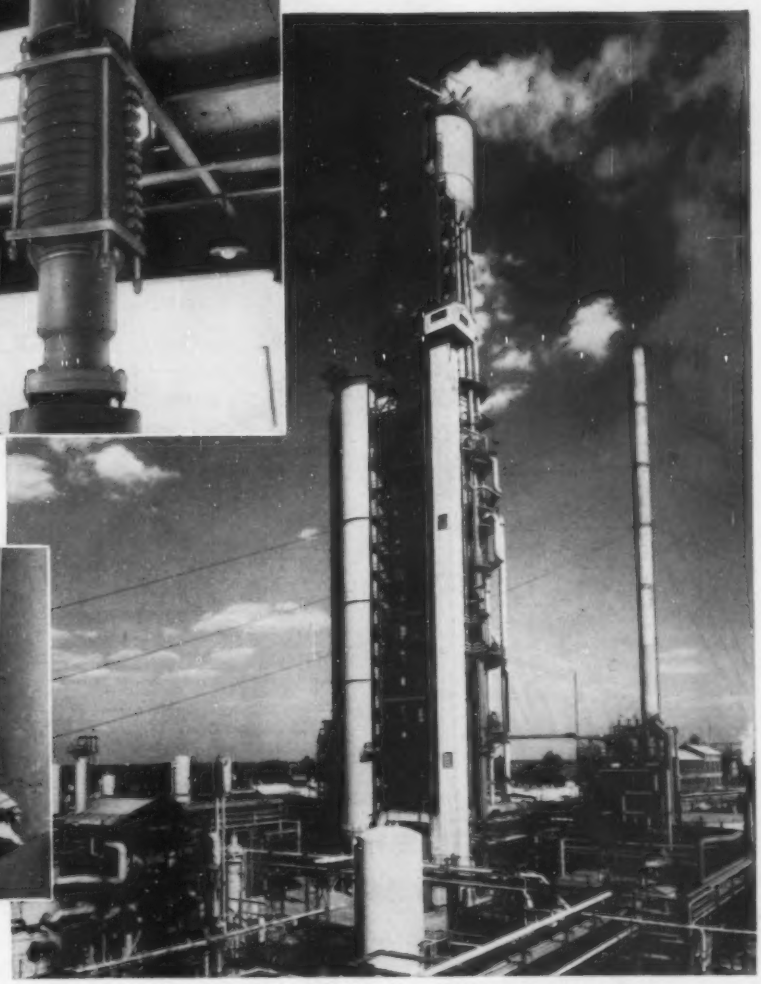
To get the most in performance when you buy your next compressor, specify Worthington with the rugged Feather Valve feature. Worthington Corporation, Harrison, N. J.

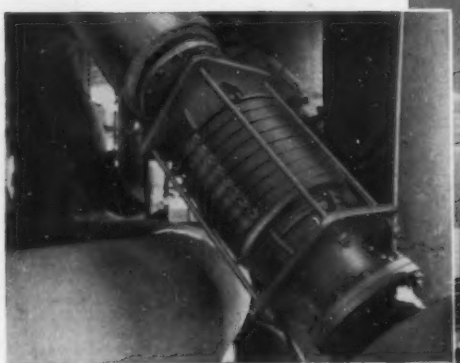
*REG. U.S. PAT. OFF.

WORTHINGTON



ADSCO Corruflex Expansion Joint with #316 stainless steel element. From the position of the tie-rods, note the pipe movement the joint is absorbing.





In this section of the Houdriflow unit, there are 12 ADSCO Corruflex Expansion Joints with #316 stainless steel elements. Temperature here is 1100°F.

Houdriflow Catalytic Cracking Unit, Marcus Hook Refinery, Sun Oil Co.

LET THE PIPES SQUIRM . . .

ADSCO

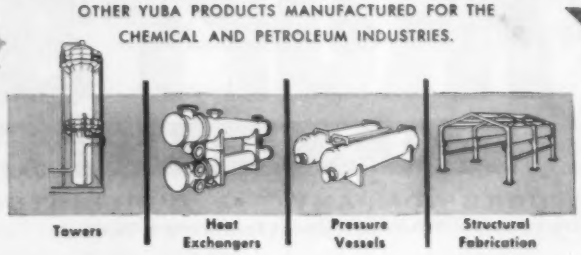
EXPANSION JOINTS ARE ON THE JOB!

Here, at the Marcus Hook Refinery of Sun Oil Co., temperatures run high. The piping naturally moves around a bit. But Sun engineers don't worry because they installed 62 Adsco Corruflex Expansion Joints to take the movement. Lateral offset, angular rotation, off-tackle slants... name it and Adsco Expansion Joints can absorb it. If you expect your pipes will get frisky, call our nearest sales-engineer, *or contact Adsco Division, Yuba Consolidated Industries, Inc., 20 Milburn St., Buffalo 12, N. Y.*

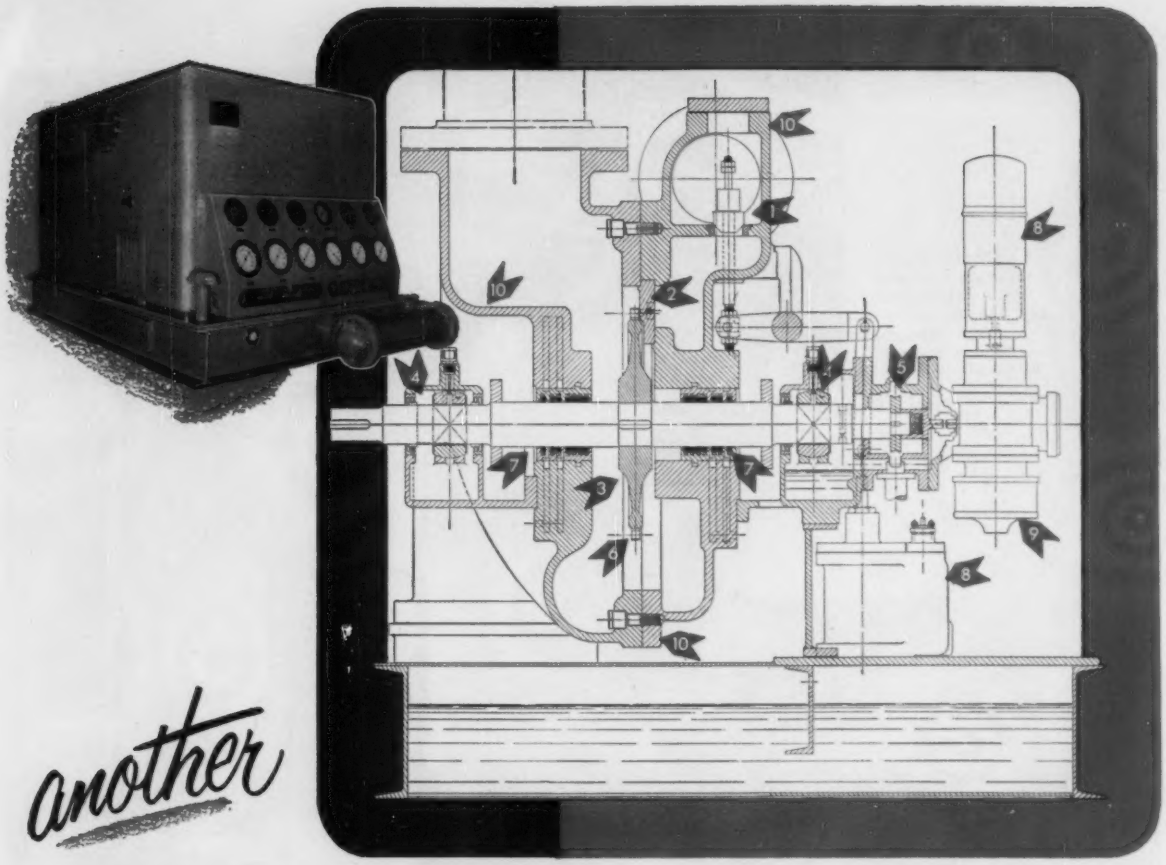
YUBA CONSOLIDATED INDUSTRIES, INC.

OTHER YUBA PRODUCTS MANUFACTURED FOR THE CHEMICAL AND PETROLEUM INDUSTRIES.

YUBA



For more data on advertised products, use Readers' Service Cards, last page.



another

MURRAY INSIDE STORY . . . OR WHY MURRAY EXCELS FOR MULTI-VALVE COMPRESSOR DRIVE

1. Multiple automatic bar-lift inlet valves.
2. Stainless steel nozzle block.
3. Specially shaped forged alloy steel disc and shaft — separate or integral.
4. Spherical seated, pressure lubricated sleeve bearings.
5. Kingsbury thrust bearing.
6. Special integral spacer type accurately formed stainless steel blades.
7. Carbon or labyrinth type gland seals.
8. NEMA Class D precision oil relay governor with hydraulic servomotor.
9. Positive displacement, shaft driven lubrication oil pump.
10. Heavy duty, rugged construction throughout.

Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.

Murray TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

FOSTER WHEELER *in Europe...*

Three major petrochemical installations in England, France and Denmark for the production of ETHYLENE and BUTADIENE—designed, engineered and constructed by Foster Wheeler.

Complete facilities for process plant design, engineering, fabrication and construction are available through Foster Wheeler Limited, London, and Société Foster Wheeler Française, Paris.

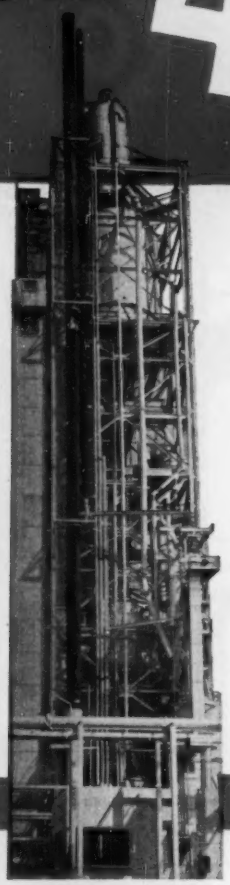
DESIGN
ENGINEERING
CONSTRUCTION

Petroleum Plants
Petrochemical Plants
Chemical Plants

Foster Wheeler Corporation, 666 Fifth Ave., New York 19, N.Y.

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT. • TOKYO

HOW 41 MAJOR REFINERIES



Catalyst erosion of lift pipes and catalyst handling lines no longer is a problem with refineries listed below. All have eliminated a costly maintenance bottleneck and speeded up turnaround operations by using "Dual Metal."

In making a "Dual Metal" lift pipe the outer shell of weldable alloy steel is poured into a rapidly rotating mold. At the proper time and temperature the abrasion-resistant alloy iron core is introduced. The metallurgically bonded two metal structure combines the strength and weldability of low alloy steel with the superior abrasion resistance of alloy iron.

In one typical refinery, "Dual Metal" high temperature catalyst pipe showed an abrasion resistance of better than 16 to 1 over conventional steel piping.

"Dual Metal" may be the answer to *your* abrasion problem. Write today for literature and information on the increasingly important part this time and money saving process is playing in the refining industry.

THESE LEADING REFINERIES

COMPANY	ADDRESS	TYPE UNIT	COMPANY	ADDRESS	TYPE UNIT
Socony Mobil Oil Co., Inc.	Trenton, Michigan	TCC 75	General Petroleum Corp.	Torrance, California	TCR
Socony Mobil Oil Co., Inc.	Brooklyn, New York	TCC 75	Magnolia Petroleum Co.	Beaumont, Texas (3)	TCC 75
Socony Mobil Oil Co., Inc.	East Chicago, Indiana	TCC 75		(1)	TCC T-5
Socony Mobil Oil Co., Inc.	Buffalo, New York	TCC 75		(1)	TCR
Standard-Vacuum Refining Co. (Australia)	Altona, Australia	TCC 75	Phillips Petroleum Co.	Woods Cross, Utah	TCC 45
Socony Mobil Oil Co., Inc.	Augusta, Kansas	TCC 75	Phillips Petroleum Co.	Okmulgee, Oklahoma	TCC 45
Socony Mobil Oil Co., Inc.	East St. Louis, Illinois	TCC 75	Continental Oil Co.	Westlake, Louisiana	TCC 60
Socony Mobil Oil Co., Inc.	Paulsboro, New Jersey	TCC 75	Continental Oil Co.	Westlake, Louisiana	TCC 75
Mobil Oil Company, Ltd.	Coryton, England	TCC 60	Delta Refining Co.	Memphis, Tennessee	TCC 20
Mobil Oil Italiana S.p.A.	Naples, Italy	TCC 75	Pontiac Eastern Corp.	Purvis, Mississippi	TCC 100
General Petroleum Corp.	Ferndale, Washington	TCC 100	Neste Oy	Naantali, Finland	TCC 45

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

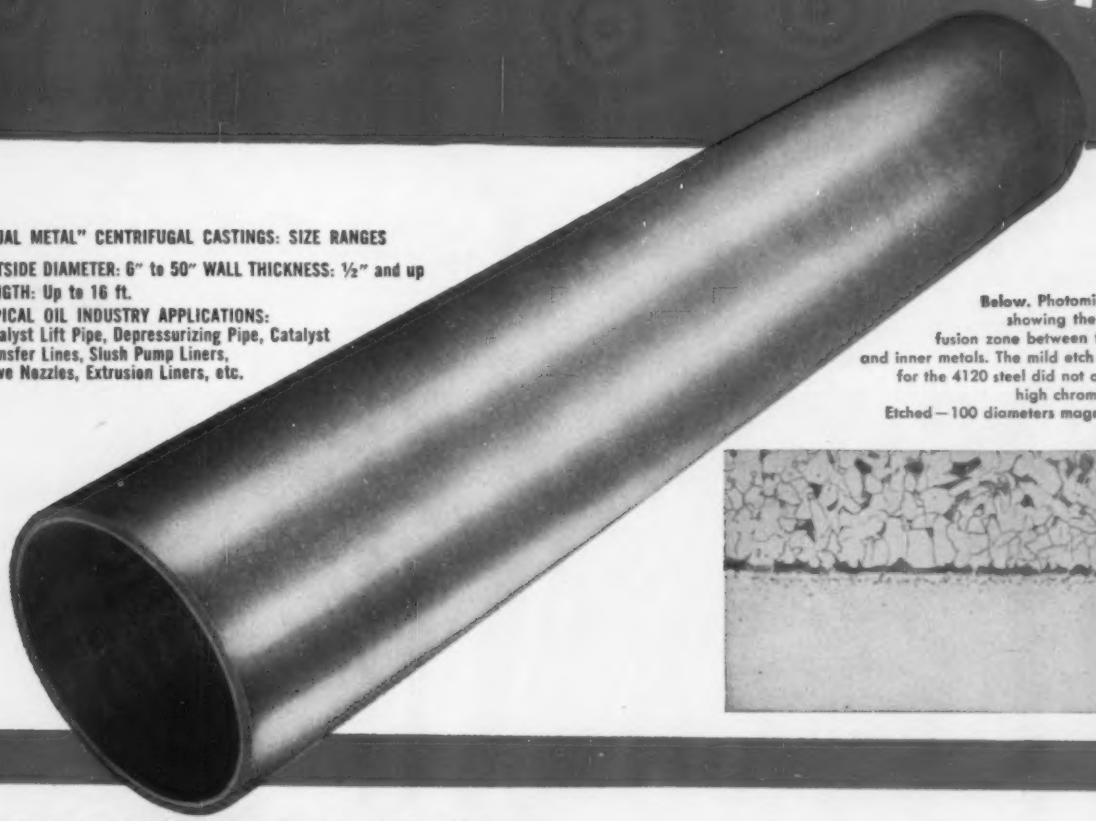
BURLINGTON, NEW JERSEY

SALES OFFICES: BURLINGTON, CHICAGO, CLEVELAND, HARTFORD, LOS ANGELES, NEW YORK, SAN FRANCISCO, ST. LOUIS

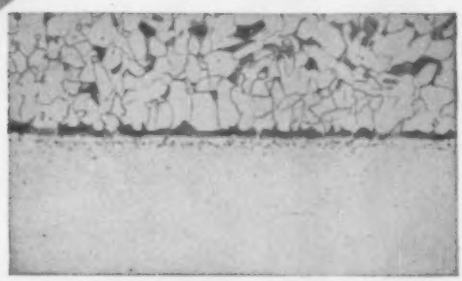
SAVE MONEY ON TURNAROUND

"DUAL METAL" CENTRIFUGAL CASTINGS: SIZE RANGES

OUTSIDE DIAMETER: 6" to 50" WALL THICKNESS: ½" and up
LENGTH: Up to 16 ft.
TYPICAL OIL INDUSTRY APPLICATIONS:
Catalyst Lift Pipe, Depressurizing Pipe, Catalyst Transfer Lines, Slush Pump Liners, Valve Nozzles, Extrusion Liners, etc.



Below. Photomicrograph showing the bond or fusion zone between the outer and inner metals. The mild etch required for the 4120 steel did not attack the high chromium iron. Etched—100 diameters magnification.



USE "DUAL METAL" LIFT PIPES

COMPANY	ADDRESS	TYPE UNIT
"ALBATROS" Societé Anonyme Belge pour le Raffinage de Pétrole Installations Pétrolifères	Anvers-Kiel, Belgium	Houdriflow
The California Oil Company	Perth Amboy, New Jersey	Houdriflow
Texas City Refining, Inc.	Texas City, Texas	Houdriflow
Commonwealth Oil Refining Co., Inc.	Ponce, Puerto Rico	Houdriflow
Salt Lake Refining Co.	Salt Lake City, Utah	Houdriflow
Pure Oil Co.	Smith's Bluff, Texas	TCC
The Shamrock Oil & Gas Corp.	Sunray, Texas	Houdriflow
Purfina Italiana S.p.A.	Rome, Italy	TCC 11
	Genoa, Italy	TCC 11

COMPANY	ADDRESS	TYPE UNIT
Bay Refining Corp.	Bay City, Michigan	TCC 33
Hancock Oil Co.	Long Beach, California	TCC 40
Chinese Petroleum Corporation	Taiwan (Formosa) China	TCC 45
CONDOR S.p.A. Societa' per L'Industria Petrolifera e Chimica	Milan, Italy	TCC 75
The Standard Oil Co. (Ohio)	Cleveland, Ohio	TCC 75
Great Northern Oil Company	St. Paul, Minnesota	TCC 100X
American Petrofina, Inc.	Mt. Pleasant, Texas	TCC 60
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Brazil	TCC 120
Turkiye Petrolleri A.O.	Batman, Turkey	TCC 20
Erdol-Raffinerie Emsland	Lingen, Germany	Houdriflow

Cross-section view of dual metal piping consisting of a weldable SAE 4120 steel outer shell and a metallurgically bonded inner layer of high carbon-high chromium abrasion resisting iron. Photograph actual size. Composition of the hard inner layer:

C	Mn	P	S	Si	Cr
2.85	1.10	.009	.023	.85	29.36

ENGINEERS "DISCOVER" ALCOA CONDUIT

Lower cost, installation economies, corrosion resistance make Alcoa Aluminum the best conduit buy

An increasing number of cost-conscious engineers are switching to aluminum rigid conduit for office buildings, industrial plants and other new and remodeled structures. Here are some of the reasons why:

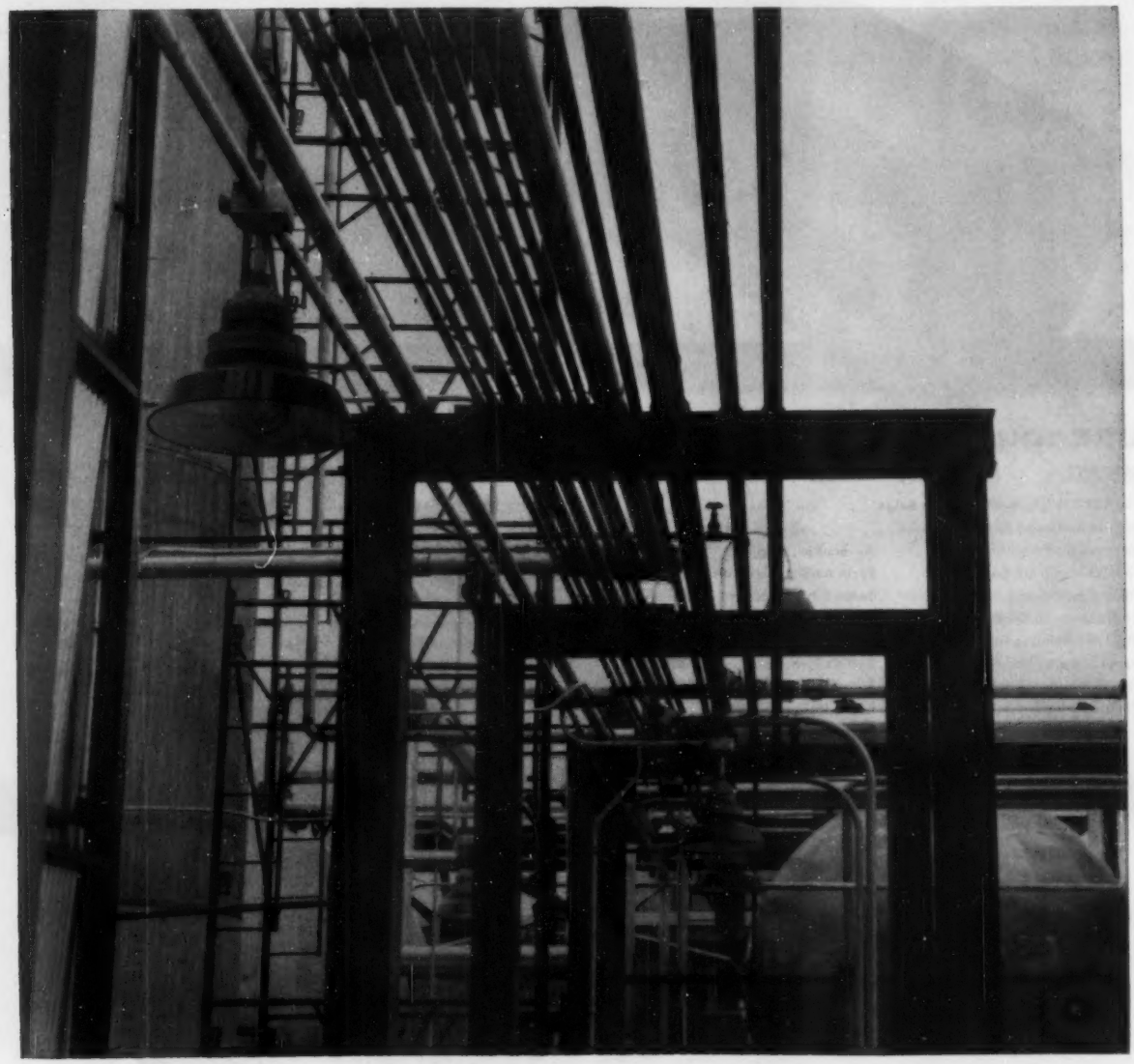
- Lower prices plus light weight and ease in handling make Alcoa® Aluminum Conduit installations competitive.
- Corrosion resistance of aluminum means less maintenance, freedom from staining.
- Aluminum is easier to cut, bend and thread. Wire pulling is easy, too, because of specially treated internal surface.
- Nonmagnetic aluminum offers up to 20 per cent less voltage drop.
- Clean, modern appearance complements modern architecture.
- Aluminum is nonsparking and has Underwriters' Laboratories, Inc., approval.

Find out why Alcoa Aluminum is your best conduit buy. Contact your electrical distributor, or write Aluminum Company of America, 2325-J Alcoa Building, Pittsburgh 19, Pennsylvania.

Your Guide to the Best in Aluminum Value

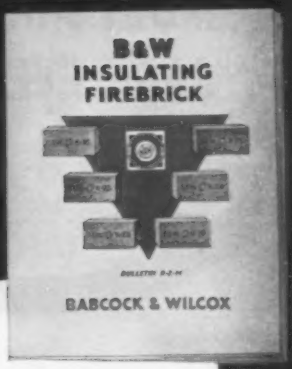
ALCOA THEATRE
Fine Entertainment
Alternate Monday Evenings

The Texas Company, Lockport, Illinois



Why B&W IFB for Oil Heater Linings ?

- Lightest weight
- Simplified construction
- High hot load strength
- Lower conductivity
- Lower heat storage
- Better process control



The light weight of B&W Insulating Firebrick provides savings in capital investment in several different ways. The light weight of B&W IFB permits thinner wall constructions of equivalent insulating value. These thinner, lighter walls mean real savings in structural steel and concrete. Construction is further simplified because B&W IFB's high hot load strength makes possible higher unsupported walls without deformation at furnace operating temperatures. In addition B&W IFB can be cut and shaped with ordinary wood working tools, simplifying field installation.

The light weight of B&W Insulating Firebrick also provides the greatest insulation. Thus, they save more fuel.

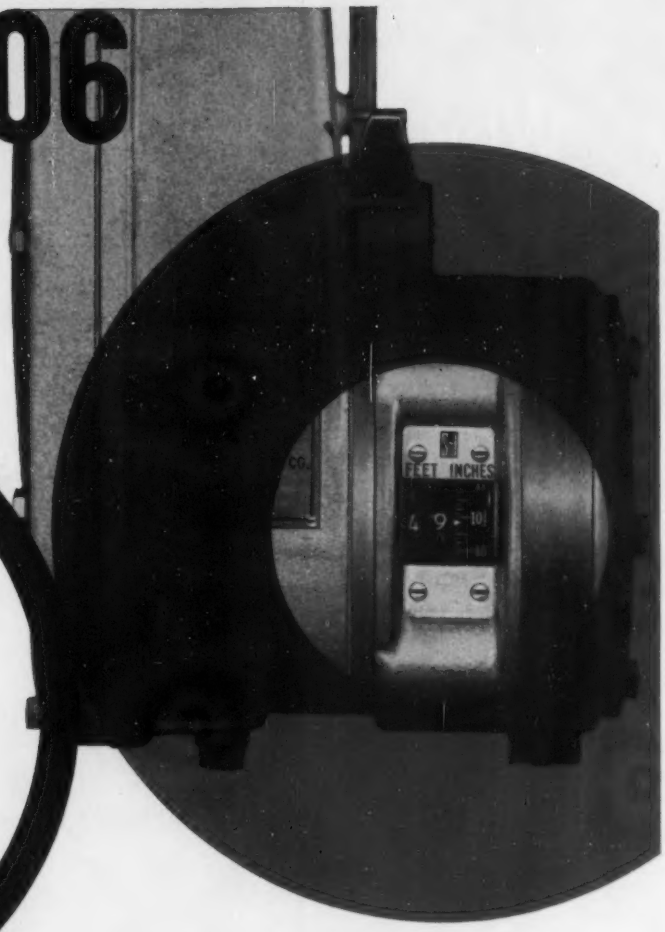
Light weight also means lower heat storage. B&W IFB protect you against burn-out of expensive alloy tubing in the event of forced shutdown. B&W IFB respond faster to changes in firing rate, too, assuring you of more positive process control.

**Write for Bulletin R-2-H giving more data on B&W Insulating Firebrick.*

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick
B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

S&J 2006



EASIEST TO READ— MOST ACCURATE GAGE EVER!

2006 contains these gagers "most wanted" features:

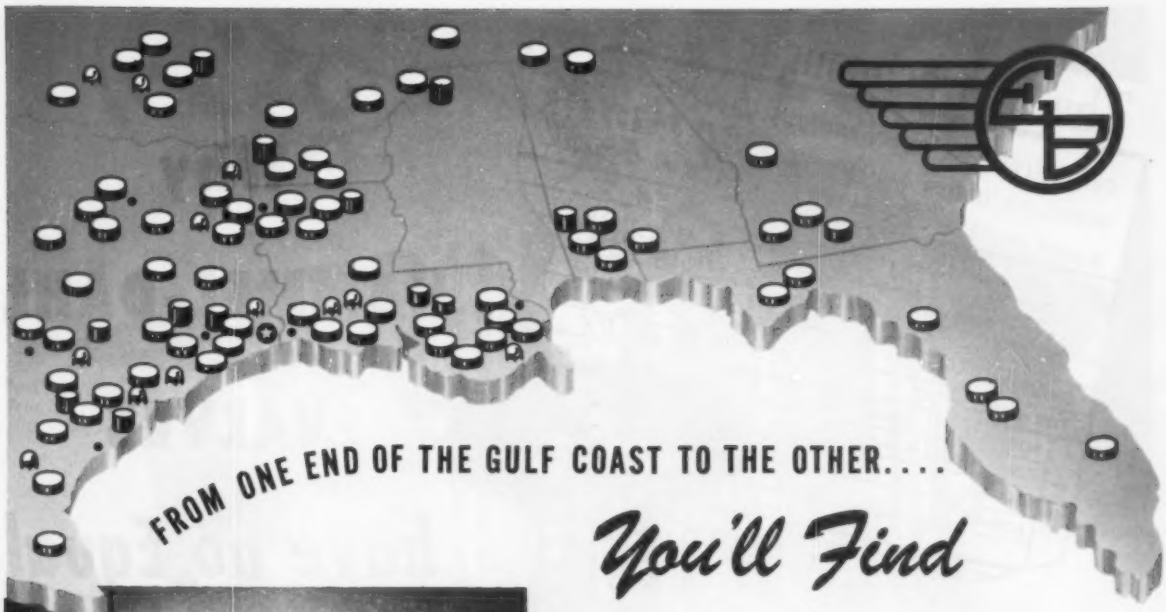
Large, white numbers on black for maximum visibility and accurate readings. Teflon bearings for minimum friction, greater gaging accuracy. Superior quality components, precision machining, clean, modern design for dependability and service. Rugged construction, minimum maintenance. Simple, fast adjustment. Easy attachment of transmitters for remote reading systems. These are some of the exclusive S&J features that make 2006 a major achievement in tank gages. Write for details today.

SHAND AND JURS GENERAL PRECISION EQUIPMENT CORPORATION GPE

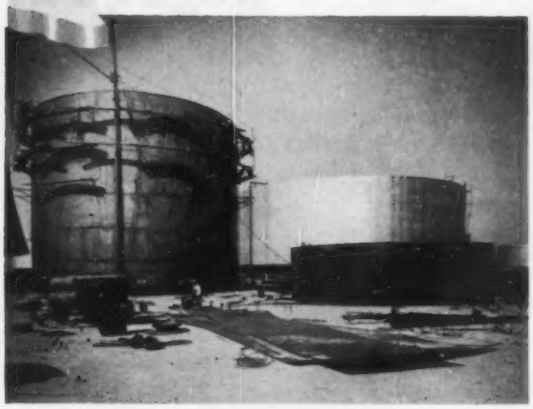
SHAND AND JURS COMPANY 2600 Eighth Street, Berkeley 10, California

4829

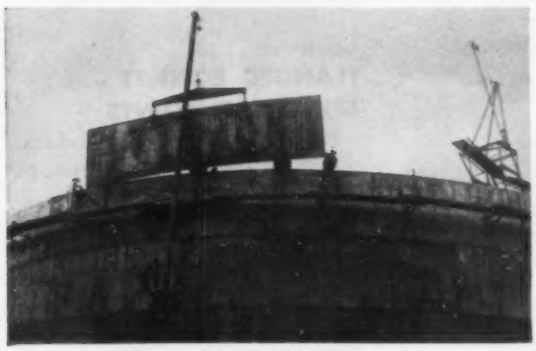
Subsidiary of General Precision Equipment Corporation
Branch offices and representatives in principal cities



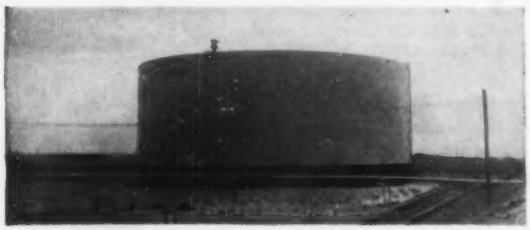
ELLERBEE TANKS



Erection of two medium size dome roof tanks.



Hanging a plate on a 96,000 barrel tank.

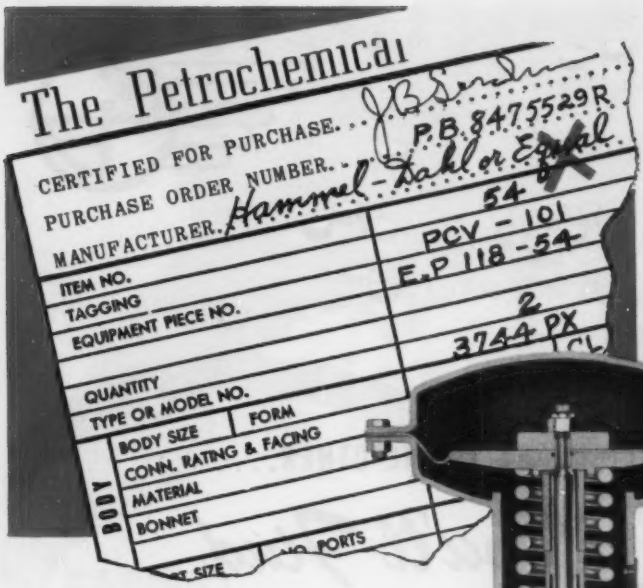


A completed 120' diameter x 48' high cone roof tank.

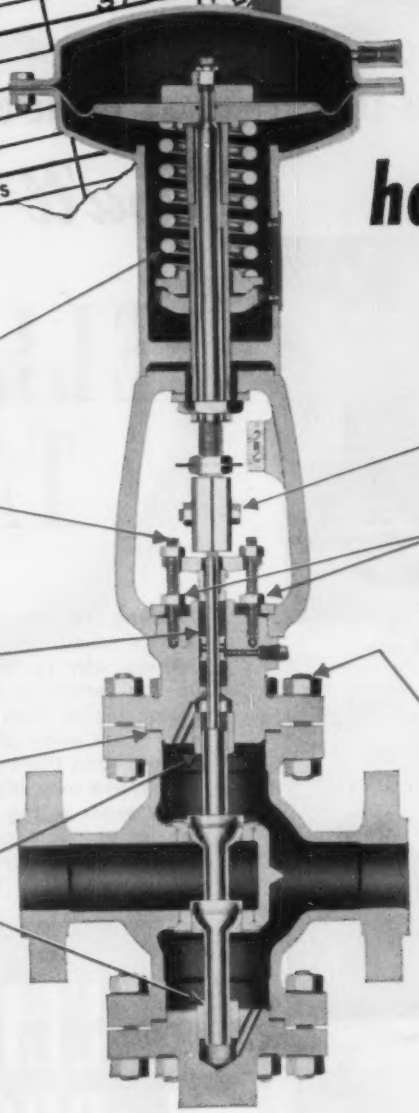
Among the many reasons why so many tanks in the Gulf coast area have been erected by Ellerbee Brothers—why so many of our clients attest to our superior service—is the attention to detail—in every step of the job from drawing board to finished tank. Every seam, every plate is exactly according to specifications—and there is an Ellerbee inspector on every job to make sure. It's trite—but still true—that the little things make a big difference in our service. Next time let us quote on any of your requirements for field erected storage tanks and spheres.

ELLERBEE BROTHERS

P. O. Box 857 Port Arthur, Texas
Phone YUkon 2-6424



X Why HAMMEL-DAHL VALVES have no Equal



because . . .
THREE SPRING RANGES
(3-15, 5-25, or 6-30 PSI) are completely interchangeable in **all** Actuators.

because . . .
BOLTED PACKING BOX
construction is standard for all sizes, types and materials. Bolts, Follower Flange, Gland, and Follower — **all stainless steel.**

because . . .
TEFLON PACKING
is standard. Lubrication not required.

because . . .
RETAINED GASKETS
prevent leakage or gasket blow-out.

because . . .
PRESSED-IN GUIDES
of honed and hardened stainless steel have no threads to corrode or erode.

because . . .
REMOVAL OF ACTUATOR
can be effected in seconds:

Loosening one bolt separates the coupling. Spring stem and plug stem are not engaged — do not meet.

Loosening two nuts permits the removal of the rugged stainless steel Actuator hold down clips.

Actuator can be lifted off the bonnet without disturbing the packing compression.

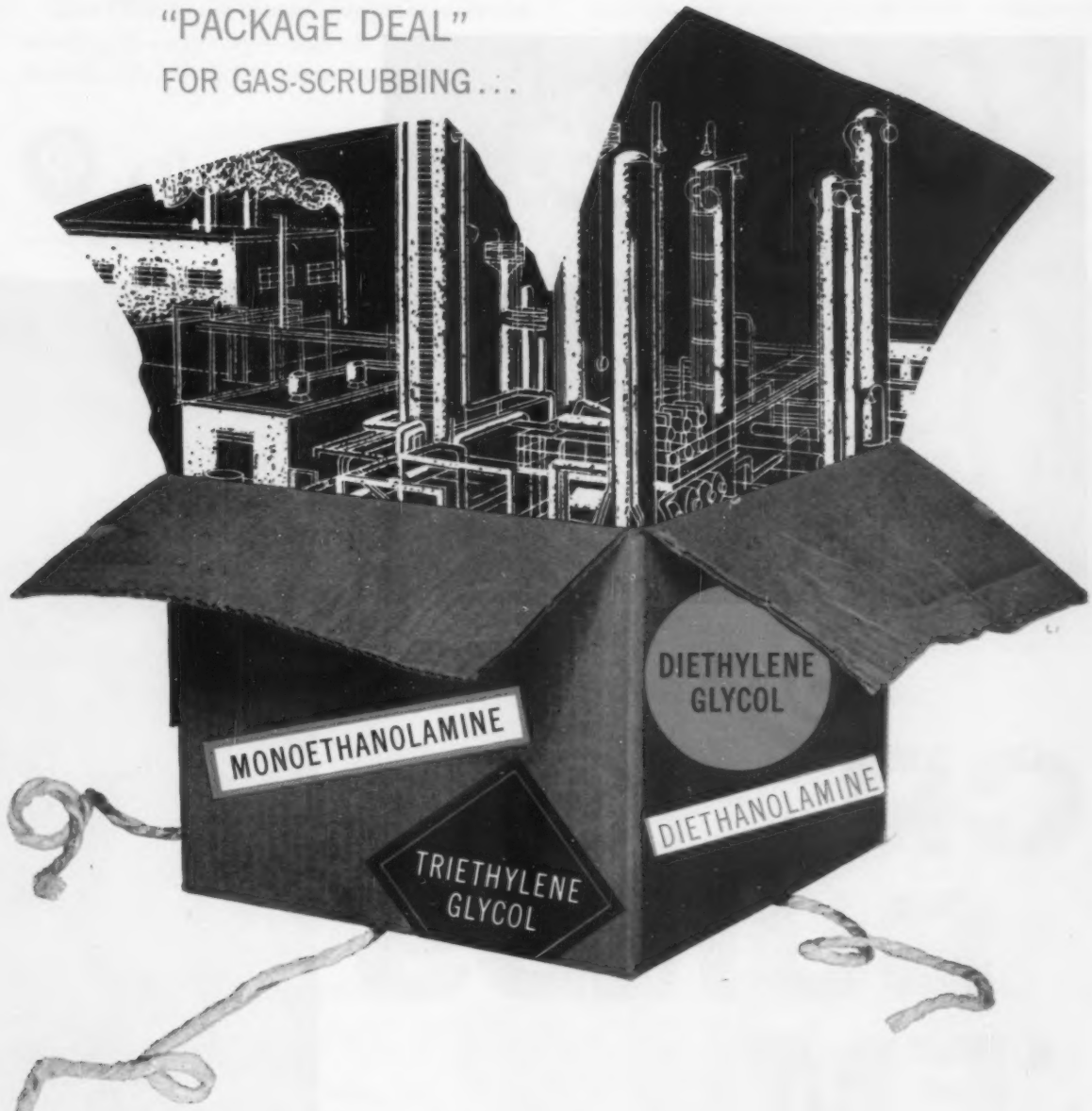
because . . .
FLANGED BONNET and **BLINDHEAD JOINTS**
standard on **all** valve types and sizes, simplify assembly and disassembly with conventional wrenches.

Through-bolting standard for most sizes. Heat-treated body studs and nuts.

FOR COMPLETE INFORMATION
WRITE FOR OUR
1958 CATALOG.

HAMMEL-DAHL
DIVISION OF GENERAL CONTROLS CO.
WARWICK INDUSTRIAL PARK • WARWICK, R. I., U. S. A.
SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD
REGIONAL STOCKING POINTS IN THE U.S.A.

HERE'S JEFFERSON CHEMICAL'S "PACKAGE DEAL" FOR GAS-SCRUBBING...



...*the right products* – to meet your needs for natural gas sweetening, refinery stream sweetening, sulfur recovery, gas dehydration, and carbon dioxide absorption.

...*at the right time* – readily available *when* you need them in the *amount* you need... bulk shipments in tank cars of 4000- to 10,000-gallon capacity, tank wagons of 1000 to 4000 gallons, or 55-gallon drums.

...*from the right place* – where technical knowledge and experience combine with modern production facilities to assure you excellent service.

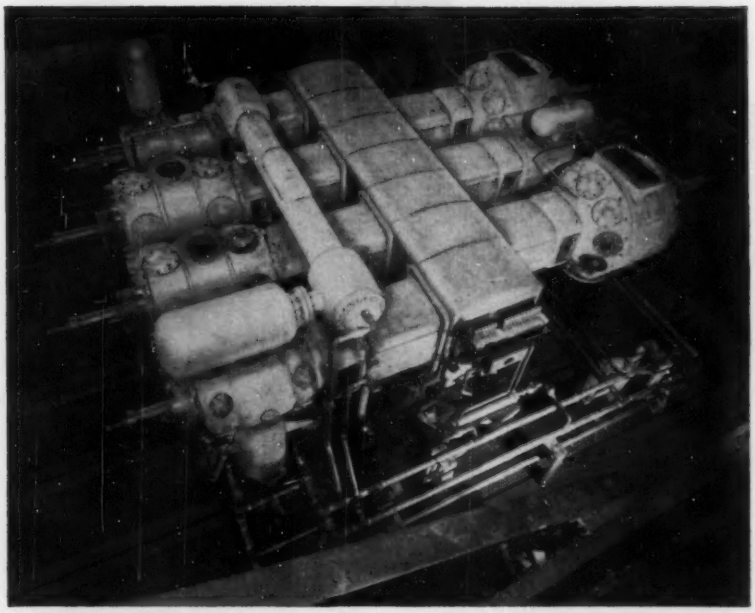
Essential Chemicals from Hydrocarbon Sources

JEFFERSON CHEMICAL COMPANY, INC.

HOUSTON • NEW YORK • CHICAGO • CLEVELAND
CHARLOTTE • LOS ANGELES

Ethylene Oxide, Glycols, Dichloride • Ethanolamines • Morpholine
Piperazine • Polyethylene Glycols • Nonyl Phenol • SURFONIC® Surface-Active Agents • Ethylene Carbonate and Propylene Carbonate
Caustic Potash • Caustic Soda • Soda Ash • Sodium Bicarbonate

For more data on advertised products, use Readers' Service Cards, last page.



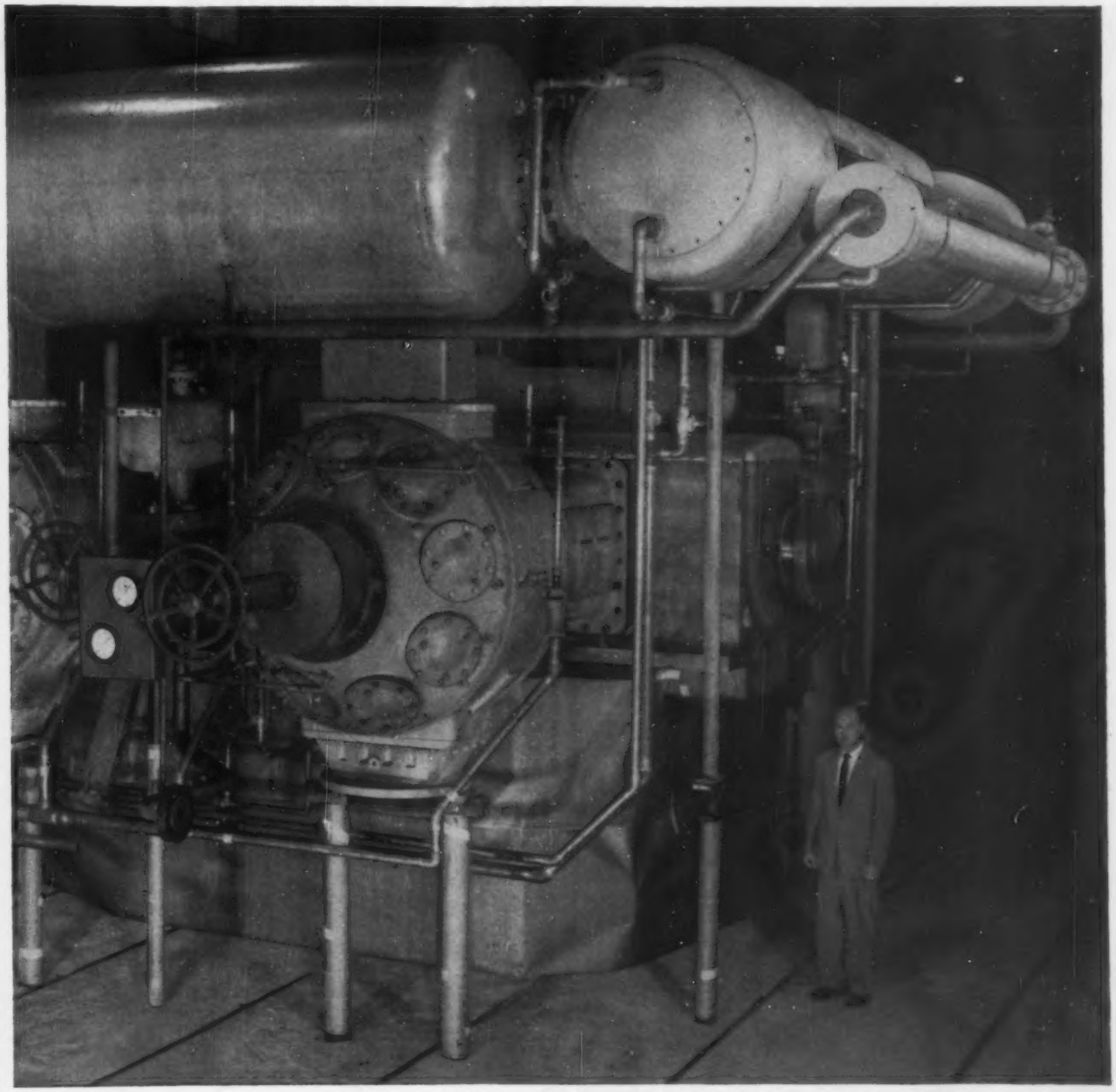
CP BUILDS 'EM BIG

This compressor *is* big! It's one of a pair of 3500 horsepower, five-stage machines built for process work.

Class FE balanced-opposed compressors are outstanding in every way – high efficiency, proved dependability, moderate ratings, accessibility. They are uniquely adaptable for widely varying conditions, in sizes up to 5000 H.P., for high vacuum or pressures up to 15,000 psig. For synthetic ammonia production, air separation, or other continuous processes, Class FE Compressors offer the utmost in efficiency and availability.

Chicago Pneumatic 8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



Variable volume clearance pockets on all stages of this Class FE Compressor control output. All components, intercoolers and piping were factory-assembled before shipment.

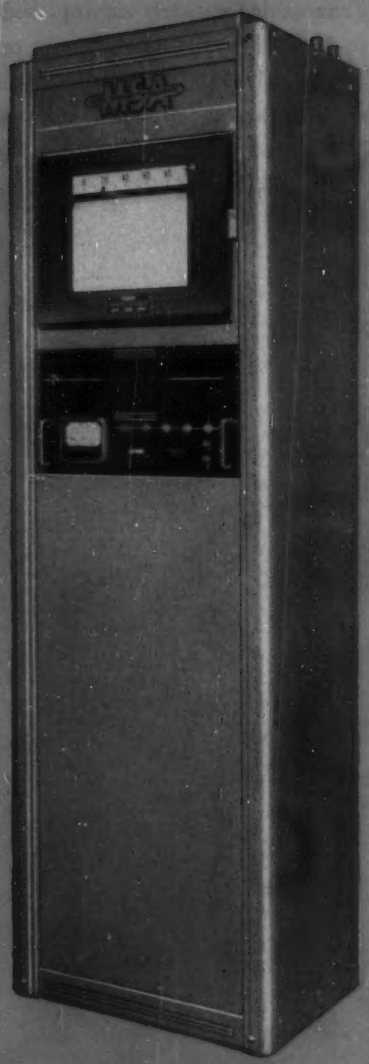
For more data on advertised products, use Readers' Service Cards, last page.

New M-S-A® Ionization Chamber detects airborne and process contaminants in the range of parts per billion

Application: air pollution studies and process monitoring

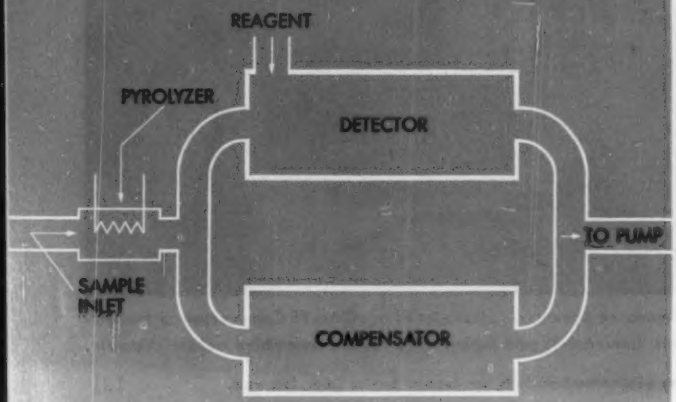
Problem: continuous, more sensitive measurement of toxic gases or vapors in traces as small as a few parts per billion

Solution: MSA's new ionization method of gas detection



MSA's new ionization detection system displays high sensitivity for acid gases such as HCl, HF, SO_2, HCN, N_2O_4; alkaline gases such as ammonia, hydrazene, amines; halogenated chlorinated hydrocarbons such as carbon tetrachloride, trichloroethylene, ethylene chloride, ethylene bromide; and some insecticides.

Schematic flow diagram shows compensated detection system using two similar ion chambers. Sample gas is drawn in through single inlet, then equally divided between two chambers. One of these, the detector chamber is supplied with constant flow of reagent (when required). The other (compensator) is not supplied with reagent.



MSA has been asking questions and coming up with the right answers in the field of gas analysis for over 30 years. Latest result of this probing inventiveness is a simplified ionization method of gas detection.

Principle of the M-S-A Ionization Chamber is unique, indeed. It measures electrically, in a specially designed ionization chamber, any decrease in the conductivity of ionized gas samples caused by removal of ions by the contaminant being measured. A radioactive material in the chamber produces continuous ionization.

Gas to be detected enters the chamber with a sensitizing reagent. Said gas may react chemically with the reagent to form sub-micron particles. Or, if the gas is electronegative, in a non-electronegative process gas, it may be detected without the need of additional sensitizing means.

Various sensitizing techniques assure a wide range of selectivity. Already, this new instrument can detect a large number of gases. The number increases as new sensitizing techniques are developed.

An MSA Instrument Specialist would be pleased to discuss in detail the materials which this device detects and measures so sensitively. Ask us for this man's name. And write us for descriptive literature.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

Graham specializes in these

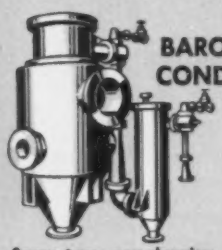
EIGHT FINE PRODUCTS . . .

each item is carefully designed for its intended duty . . . and represents over a quarter of a century's experience

MONOBOLT HEAT EXCHANGERS

This patented Graham Heat Exchanger permits the inside of the tubes to be available for cleaning in a matter of minutes and further removal of the tube bundle is a cinch. In service and where frequent cleaning is desirable, Monobolt is a sure winner.

BAROMETRIC CONDENSERS

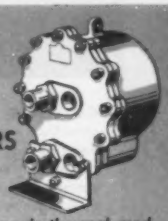


Spray type, non-clogging, built for a wide range of applications and in many materials. The Graham Barometric is flexible, reliable and has been used for hundreds of varied duties.

STEAM VACUUM REFRIGERATION

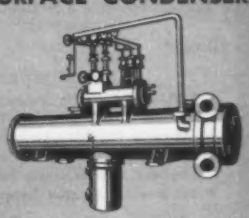
The Graham system is far in advance of all others and will efficiently cool your process water with maintenance practically nil. Hundreds of these units are operating all over the world. Made in all sizes and for virtually every operating condition.

HELIFLOW HEAT EXCHANGERS



The Graham Heliflow is the real modern way of exchanging heat without encountering any of the troubles so typical of the conventional tube and shell unit. The spiral coil gives high rates of heat transfer, close terminal differences, and most economical performance in dollars invested per BTU.

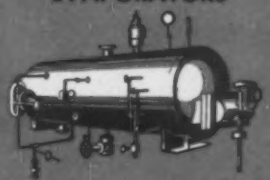
SURFACE CONDENSERS



The Graham Surface Condensers represent the most advanced designs. The Graham patented tube sheet layout assures full distribution of steam and maximum vacuum at the condenser inlet. Coupled with the Graham Steam Jet Ejector, it offers a most efficient package unit.

Graham

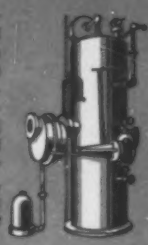
EVAPORATORS



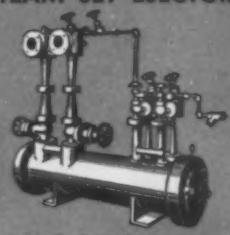
The Graham Evaporator is based on really scientific design—not only the result of many field tests on actual Graham Evaporators but it is based on conclusive accurate tests run in our well equipped laboratory at the factory. They are designed for all concentrations and in a great range of sizes.

DEAERATING HEATERS

The Graham Deaerator is a tried and proven performer. Its efficient construction gives you the maximum area of exposure for heating and deaerating. It will cut corrosion in your evaporator, boiler, piping, etc. It is a very economical unit to purchase.



STEAM JET EJECTORS



The name Graham is synonymous to Steam Jet Ejectors. They are made in any size, for any vacuum and for all applications. Deliveries are assured. Graham Ejectors are noted for their high efficiency.

It will pay you to ask us for a quotation when you are in the market for any of these products

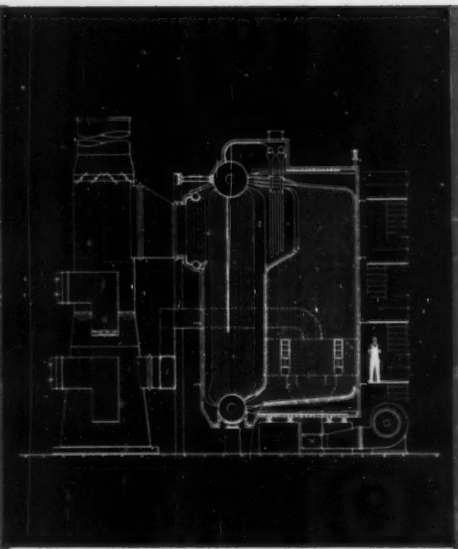
GRAHAM MANUFACTURING CO., INC.

415 LEXINGTON AVE., NEW YORK 17, N. Y.

Offices in principal cities and Canada

Heliflow Corporation

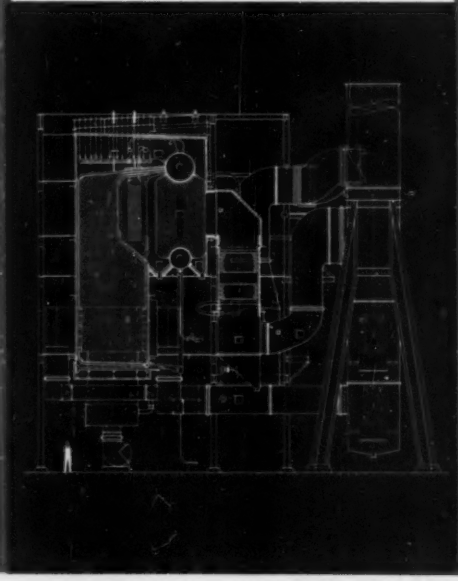
Drop us a postal card and we will mail you additional literature — no obligation



C-E VU-50B CO Boiler (above)—offers same construction and design as C-E's standard VU types. Features tangent waterwalls—welded skin casing—tangential firing—minimum number of baffles—economic advantages of bottom supports. Proven in hundreds of installations, this VU design gives high standards of performance with economy of operation, reliability, and minimal maintenance. This design is especially suitable where the quantities of CO gas burned are relatively small.

The design on this page represents a plan section diagram showing arrangement of C-E Tangential Burners for firing a completely water-cooled furnace.

C-E VU-40 CO Boiler (below)—this is a top-supported CO boiler installed at a Gulf Coast refinery. The plant cycle for this unit combines a catalyst regenerator, two gas turbine-driven compressors, two CO boilers, and separate turbine exhaust gas feedwater heaters located between the boilers.



Now tangentially fired C-E boilers for any quantity of catalyst regenerator gas for any quantity of steam required

which assure

- complete combustion
- maximum control
- low power consumption
- minimum exposed refractory

C-E now has an expanded line of CO boilers that offer refineries the opportunity to profitably use the energy potential of even small quantities of catalyst regenerator gas. This makes available to refiners a wide range of C-E CO boiler sizes, all offering *big boiler* features. *All* incorporate the advantages of Combustion's service-proved VU-40, a top-supported design, or the smaller, more economical bottom-supported VU-50B boilers – and all are tangentially fired.

Tangential firing assures efficient combustion of CO gas with a minimal use of supplemental fuel... not only at high loads, *but also at low load*. Tangential burners assure the turbulence and complete mixing essential to efficient burning when the CO fuel mixture is injected into the furnace from minimum to maximum load.

Combustion's widespread experience has encompassed all types of steam generating equipment, including many installations firing lean fuels. If you have need of a boiler to burn catalyst regenerator gas, it's C-E for CO.

For detailed catalog on CO Boilers by C-E, mail this coupon.

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

COMBUSTION ENGINEERING

C-178

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

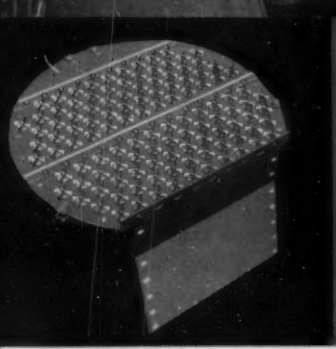
KOCH FLEXITRAYS

add higher capacities and efficiencies to Cities Service giant fractionating tower

This huge splitter, 13′ 6″ I. D. x 208′ 6″ overall length, erected in the Cities Service Refinery in Lake Charles, La., is believed to be the largest pressure vessel ever erected in one piece.

Koch Flexitrays make it tick. Flexitrays often save refineries and chemical plants 20% - 40% on total cost of complete tower installations.

On your next tower be sure to investigate Koch Flexitrays. The marked success of this low-priced tray has resulted in its use in more than 800 non-captive installations.



Contact your nearest Koch Representative, or write direct to...

KOCH

ENGINEERING COMPANY, INC.

321 West Douglas Avenue, Wichita 2, Kansas

Continuing progress through research

REPRESENTATIVES

BUTTE, MONTANA — G. M. Wallace & Co., P. O. Box 208
DENVER, COLORADO — G. M. Wallace & Co., 324 Denham Bldg.
EL PASO, TEXAS — G. M. Wallace & Co., Suite 511, Electric Bldg.
HOUSTON, TEXAS — Alpha Engineering Co., P. O. Box 17371
KANSAS CITY 13, MISSOURI — Semple Brothers, P. O. Box 7051
NEW YORK 17, N. Y. — F. J. McConnell Co., 50 East Forty-Second St.
OAKLAND, CALIFORNIA — Engineered Process Equip. Co., 600 Sixteenth St.
PARK RIDGE, ILLINOIS — M. R. Fisher, 1521 Courtland Ave.
PASADENA, CALIFORNIA — Engineered Process Equip. Co., 774 East Green St.
PITTSBURGH 19, PENNSYLVANIA — D. D. Foster Company, 2210 Koppers Bldg.
SALT LAKE CITY, UTAH — G. M. Wallace & Co., Continental Bank Bldg.
SOUTH CHARLESTON, WEST VIRGINIA — D. D. Foster Co., 411 "D" St.
ST. LOUIS 17, MISSOURI — Semple Brothers, 2010 Big Bend Blvd.
TULSA, OKLAHOMA — W. C. Myers Co., Wright Building

Replace with PULSAFEEDER for Trouble-Free Liquid Metering

NO LEAKAGE
NO CONTAMINATION
NO PRIME LOSS
NO STUFFING BOX

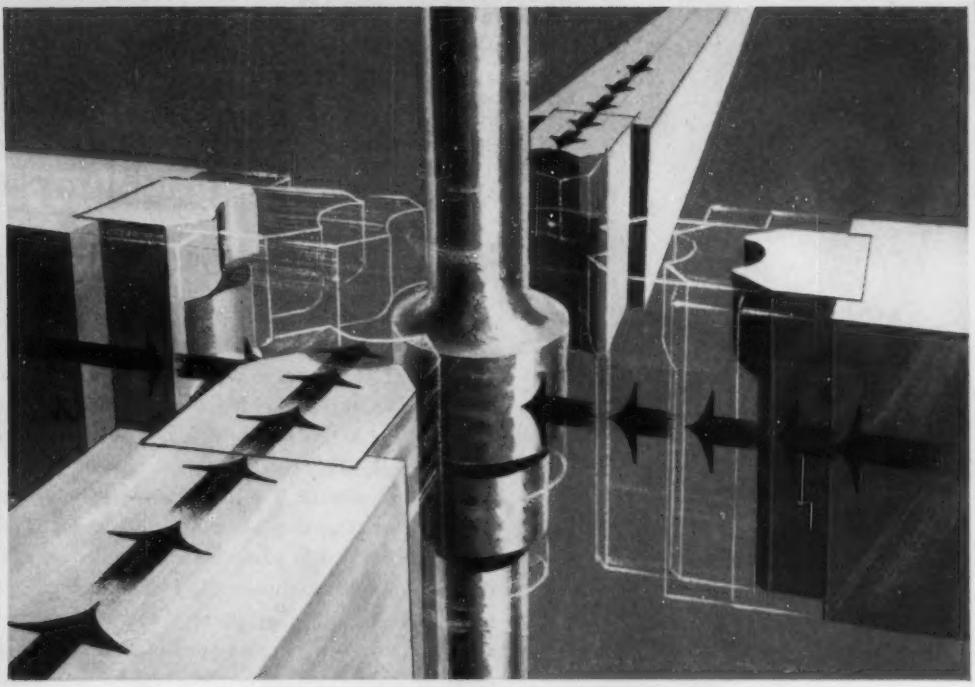
When the time comes to replace the chemical pump in your process, replace with a PULSAFEEDER—the *leak-proof* chemical pump that has *no stuffing box* or other leak-likely seal.

Lapp Pulsafeeder is a combination piston-diaphragm pump . . . positive displacement is achieved by a reciprocating piston pumping a hydraulic oil against a diaphragm. This hydraulically balanced diaphragm isolates the liquid being pumped from the pump's working parts—eliminates need of stuffing box or running seal—prevents product leakage and contamination. Pumping speed is constant, variable flow results from variation in piston-stroke length . . . controlled manually by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable process variable.

WRITE FOR BULLETIN 440
with typical applications, flow charts, description and specification of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 3403 Poplar Street, Le Roy, N. Y.

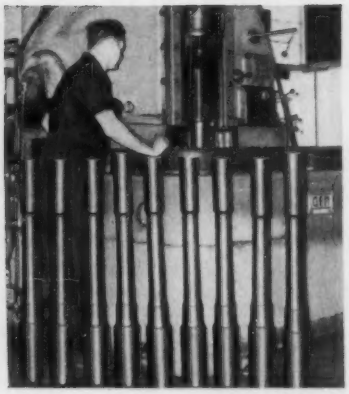
Lapp PULSAFEEDER
CONTROLLED-VOLUME CHEMICAL PUMP

For more data on advertised products, use Readers' Service Cards, last page.



ANOTHER CURMET PROCESS

New Precision ROTARY FORGE saves up to 30% on Finished Parts



Curtiss-Wright Exclusive Rotary Forge produces precision parts . . . saves industrial buyers from 15% to 30%.

Producing complex solid or hollow parts from *less metal* and with *greater accuracy*, the Curtiss-Wright Rotary Forge provides industry with a new, economical source for precision forgings.

Parts are hot-forged in this CURMET process to tolerances of .015 inches outside and .005 inches inside or to still higher tolerances when cold forged. Expensive finishing time is cut down, chip loss is minimized and added strength and toughness assured . . . with overall savings on the forged part of up to 30%.

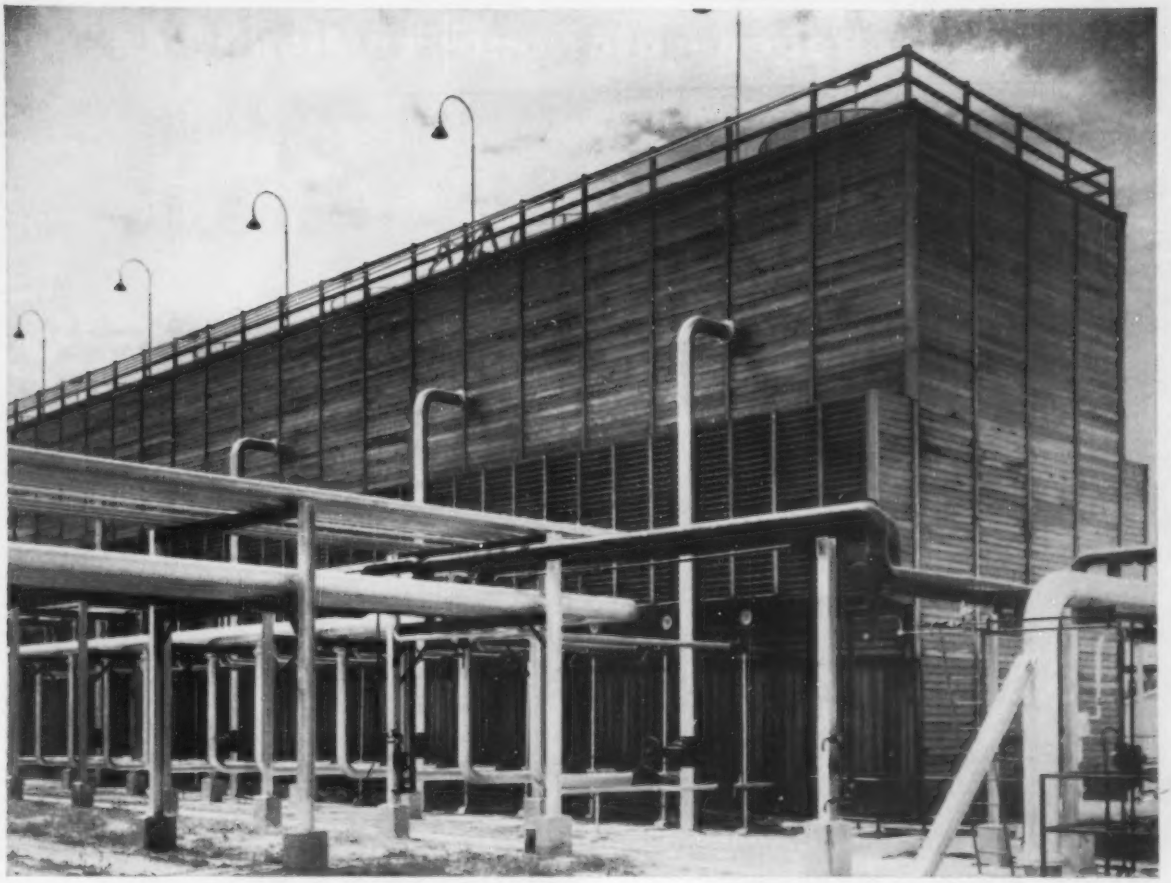
The Rotary Forge, only one of its type in the United States, shapes parts by synchronized blows of four hammers, each striking up to 600 times a minute. Tapered steel truck axles, for example, are produced to accurate dimension in 25 seconds. Because dies are comparatively inexpensive, orders in moderate volume can be filled at lowered costs.

High pressure gas cylinders, jet nozzles, venturis and other precision components for transportation, oil, electric motor and other industries can be forged to your order by this new CURMET process.

FOR FULL INFORMATION, WRITE TO:

METALS PROCESSING DIVISION
760 Northland Avenue

CURTISS-WRIGHT CORPORATION
Buffalo 15, New York



CHROMATE COMPOUNDS STOP CORROSION *before it starts!*

Long before the first drop of water contacts metal in any large recirculating water system, steps should be taken to prevent corrosion.

Early in the design stage, plan on adding a chromate inhibiting compound to recirculating water—from the moment operation starts. That way, clean metal stays clean. Chromate inhibiting compounds will also arrest corrosion in older systems that have been operating without protection, even where rust and scale make it more difficult for inhibitors to reach and protect the metal.

Chromates work two ways: they make waters non-corrosive while making metal surfaces corrosion-resistant. Chromate inhibiting compounds are easy and inexpensive to use. Since conditions and equipment vary, a variety of compounds are available to meet individual requirements.

For the names of manufacturers of corrosion inhibiting compounds containing Mutual Chromium Chemicals, or information on Mutual Chromium Chemicals, mail the coupon below.

Mutual® Chromium Chemicals

Sodium Bichromate
Sodium Chromate
Chromic Acid
Potassium Bichromate
Potassium Chromate
Ammonium Bichromate
Koreon (one-bath chrome tan)

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

MUTUAL Chromium Chemicals are available through dealers and SOLVAY branch offices located in major centers from coast to coast.

MUTUAL CHROMIUM CHEMICALS
SOLVAY PROCESS DIVISION
Allied Chemical Corporation
61 Broadway, New York 6, N. Y.

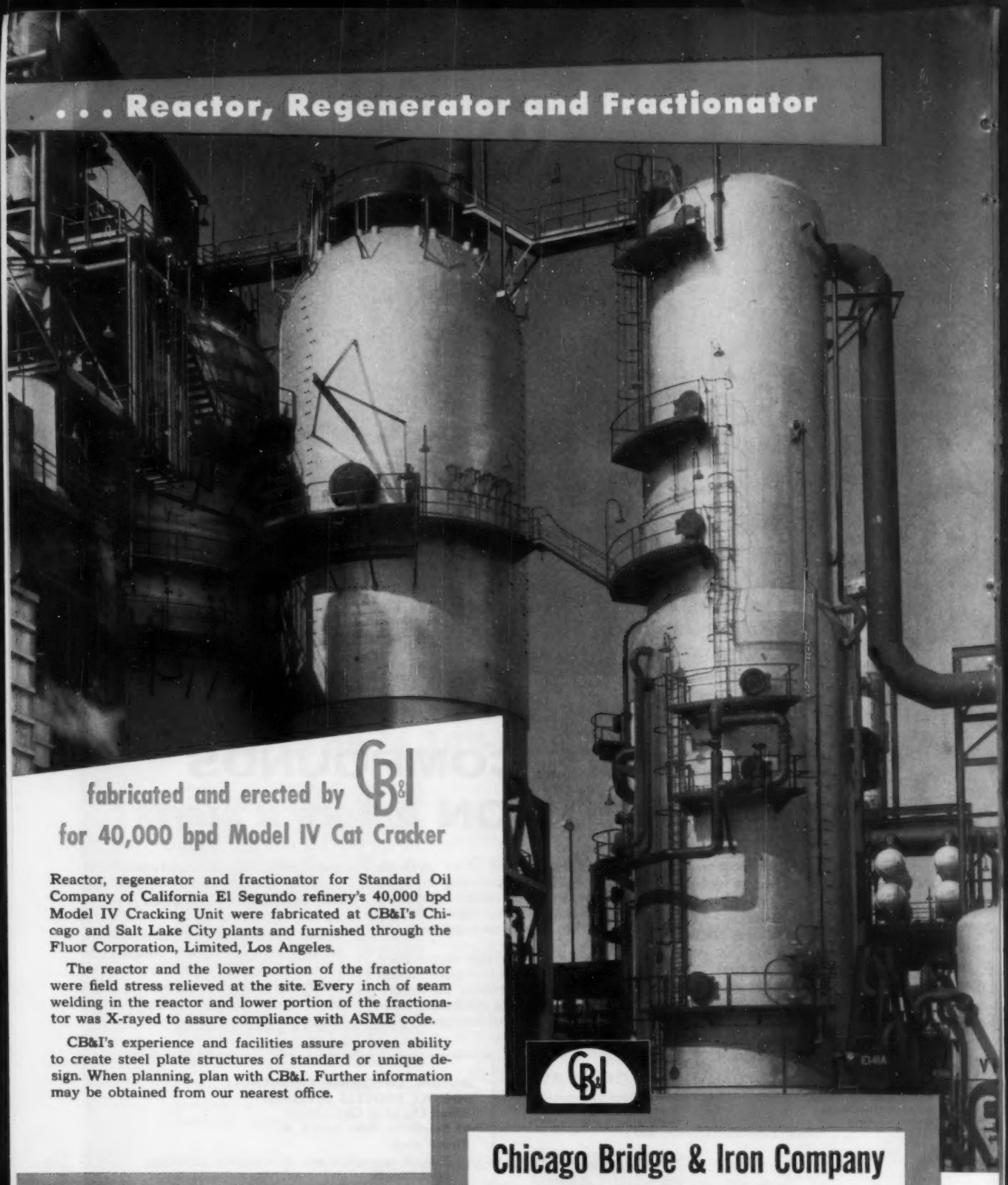
Please send:

☐ List of manufacturers of corrosion inhibiting compounds.
☐ Booklet "Mutual Chromium Chemicals."

Name_____ Position_____
Company_____
Street_____
City_____ Zone____ State_____

23-98

For more data on advertised products, use Readers' Service Cards, last page.



. . . Reactor, Regenerator and Fractionator

fabricated and erected by CB&I for 40,000 bpd Model IV Cat Cracker

Reactor, regenerator and fractionator for Standard Oil Company of California El Segundo refinery's 40,000 bpd Model IV Cracking Unit were fabricated at CB&I's Chicago and Salt Lake City plants and furnished through the Fluor Corporation, Limited, Los Angeles.

The reactor and the lower portion of the fractionator were field stress relieved at the site. Every inch of seam welding in the reactor and lower portion of the fractionator was X-rayed to assure compliance with ASME code.

CB&I's experience and facilities assure proven ability to create steel plate structures of standard or unique design. When planning, plan with CB&I. Further information may be obtained from our nearest office.

40,000 bpd Model IV Catalytic Cracking Unit at Standard Oil Company of California's El Segundo refinery. The reactor, regenerator and fractionator were fabricated and erected by CB&I.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

REPRESENTATIVES AND LICENSEES:
Australia, England, France, Germany, Italy, Japan, Netherlands, Scotland

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Sociedade Chibridge de Construcoes Ltda., Rio de Janeiro.

YOUR BEST BUY

for top performance, long life, low upkeep . . .

Leopold

WATER PURIFICATION AND FILTER PLANT EQUIPMENT

LEOPOLD GLAZED TILE FILTER BOTTOMS

• Permanent • Can't corrode • Acid and alkali-resistant • Not subject to tuberculation • Performance proved in over 375 plants with a daily capacity of over 2¾ billion gallons.

LEOPOLD FIBERGLASS-REINFORCED PLASTIC WASH TROUGHS

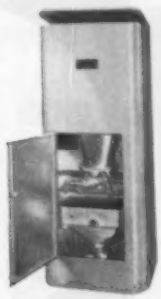
• Require no painting or other costly maintenance • Easy to handle—inexpensive to install • Resist weather and last indefinitely • Available for all design requirements. Also ideal for weir plates, collector troughs, baffles, etc.

LEOPOLD RUBBER-SEATED BUTTERFLY VALVES

• Provide positive bubble-tight closure • Designed for quick, economical installation, easy operation, minimum upkeep.

LEOPOLD FILTER OPERATING TABLES

• More than 2000 now in service • Furnished in standard models or special designs for individual requirements with electric, hydraulic or pneumatic indicators. Also hydra-pneumatic control systems.



LEOPOLD DRY CHEMICAL FEED MACHINES

• Available in three capacities for fast volume batch feeding of dry chemicals.

Whether adding new plant capacity or modernizing present facilities, it will pay you to use Leopold Filter Plant Equipment. You'll find Leopold products can't be beat for efficiency, long life, and overall economy. Any way you judge them, they're your best buy. We would like to give you valid reasons why—without obligation. Just mail coupon below.

Leopold also manufactures flash and vertical-shaft type mixing equipment.

MAIL COUPON TODAY FOR LITERATURE— COMPLETE DETAILS!

F. B. LEOPOLD CO., INC.
Zelienople, Pa.

Gentlemen:

☐ **Please send literature on complete line of Leopold products.**

☐ **Please have representative call.**

Name_____

Affiliation_____

City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

FOR OVER A DECADE . . .

A perfect record of performance & SAFETY

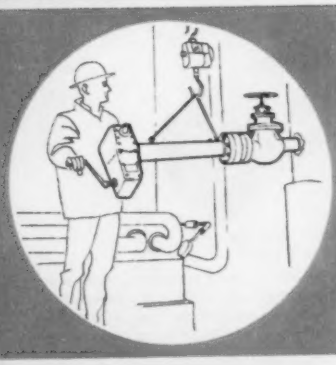
ON PIPELINES

SAFE TAPS INTO:
- STEAM
- ETHYLENE

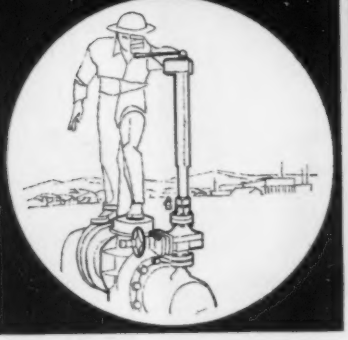
IN PROCESS PLANTS

SAFE TAPS INTO:
- NATURAL GAS
- NITROGEN

WmSON-HILLCO
TAPPING MACHINES



SAFE TAPS INTO:
- PROPANE
- GASOLINE



SAFE TAPS INTO:
- OIL
- SALT WATER

4 Machines:

MODEL 1200 — 12" thru 36" taps
MODEL 660 — 3" thru 16"
MODEL 360 — 1" thru 6"
MODEL 100-C — ½" thru 2"

PROVEN *by thousands of hot taps . . . This experience means SAFETY for the protection of lives and property.*

"PIONEERS IN PIPELINE EQUIPMENT"

T.D. Williamson, Inc.

P. O. BOX 4038 TULSA 9, OKLAHOMA

Representatives: HOUSTON • AMARILLO • JOLIET, ILL. JACKSON, MICH. • LONG BEACH • SAN FRANCISCO BARTLESVILLE, OKLAHOMA • SEATTLE • SALT LAKE CITY • EDMONTON • TORONTO • VANCOUVER BUENOS AIRES • MONTERREY AND MEXICO CITY CABIMAS, ZULIA VENEZUELA • DURBAN, NATAL, S. AFRICA • PARIS, FRANCE • SYDNEY, AUSTRALIA

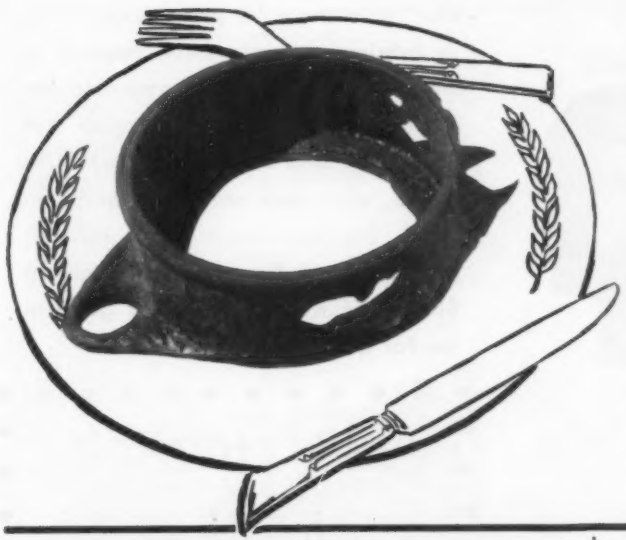
EACH MODEL RATED AT:
1440 PSI @ 100° F or
700° F @ 700 PSI
EACH MACHINE TESTED TO 2,175 PSI

Write for Rental – Purchase Information

ENGINEERING

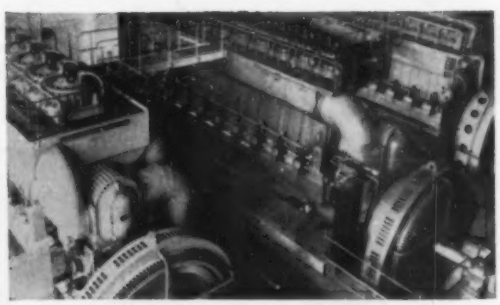
NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

BIG MEAL FOR CORROSION!



INSIST ON CORROSION-RESISTANT COOK PACKING GLANDS

Even in the very toughest service, there's no excuse for rust and corrosion eating away your packing glands. In 999 cases out of 1000, packing glands of Cook stainless steel or *Ni-Resist* type iron will solve the problem. For the remaining 1 problem in 1000, Cook can probably design an answer. That's because C. Lee Cook pioneered in the field of metallic packings — knows more about their specific, on-the-job use than anyone else. Insist on genuine C. Lee Cook parts and service.



COOK RINGS IN DIESEL SERVICE 3 YEARS—STILL GOING STRONG

Here's a report on Cook rings at Rockville Centre, N. Y. municipal power plant. It's the result of a cylinder inspection on their No. 8 diesel unit after nearly three years of continuous operation.

"While several rings were replaced in Grooves 1 and 2, Cook rings in Grooves 3, 4, 5 and 6 could run for another 10,000 hours! And cylinders averaged less than .001" maximum wear per 1000 hours of operation."

"Piston Rings and Engine Power"

SEND FOR FREE 8-PAGE BOOKLET!

Write for your free copy of this technical article on the importance of keeping piston ring faces to the wall... an informative study of the effects of piston ring problems on the various types of engines and their operation. Write C. Lee Cook Company, 950 South 8th Street, Louisville 3, Kentucky.

C. LEE COOK COMPANY

Division of Dover Corporation

Rings and Packings Since 1888

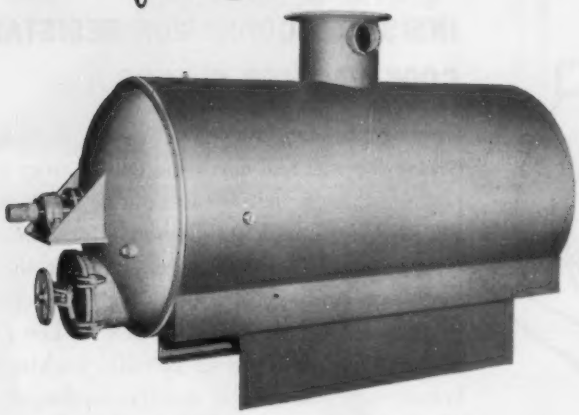
For more data on advertised products, use Readers' Service Cards, last page.

FELKER BROS. MFG. COMPANY

Metal Fabricators for OVER 50 YEARS

MARSHFIELD, WISCONSIN
Phones — 230 and 231

FELKERWELD for Endurance



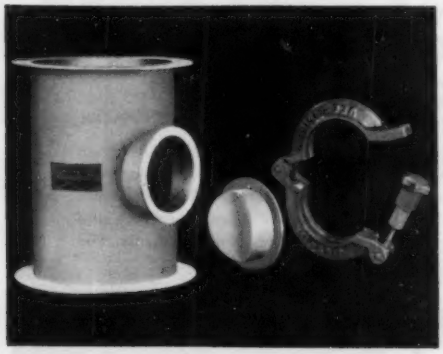
• A Pressure Cooker of open hearth mild steel fabricated to customer specifications.

Our more than 50 years' experience in fabricating plain steel, applied to stainless steel when it came into the market enabled us to develop our FELKERWELD PROCESS for ENDURANCE, with such metals as Stainless Steel, Stainless Clad Steel, Inconel, Monel, Nickel, Copper and Aluminum Bronze. FELKERWELD is your guarantee for quality workmanship.

ASME Code

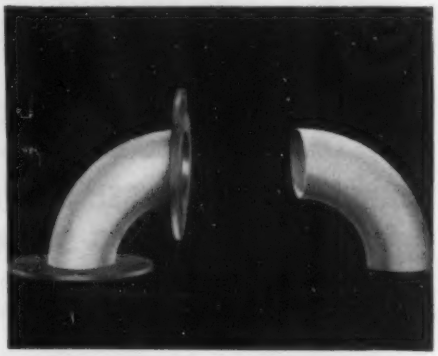
Our shop is qualified for construction under the A S M E Code for unfired pressure vessels, paragraph U-69 and U-70.

We Fabricate to Your SPECIFICATIONS



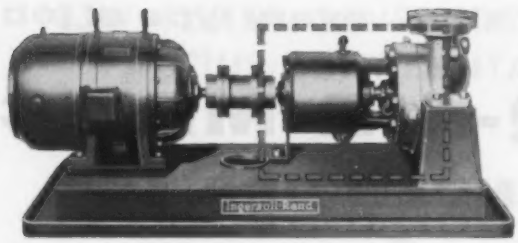
• FELKERWELD plug type CLEAN OUTS with quick opening Vee Grip Flange.

We invite inquiries on any Fabricated Products . . . write, phone or wire . . . estimates promptly furnished. Ask for our Bulletin No. 505.

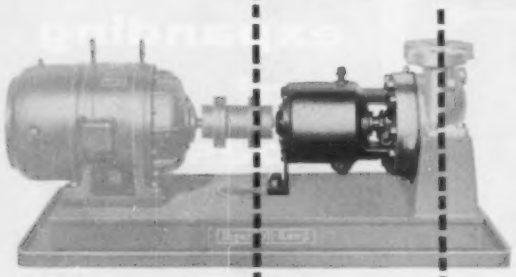


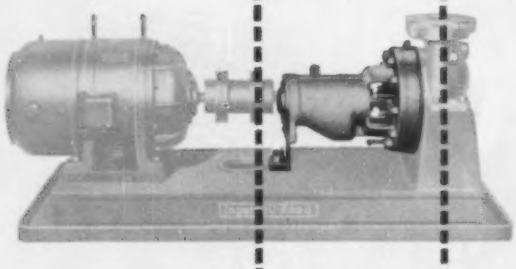
• FREEFLOW Type Stainless Steel Elbows —Fittings available in all metals.

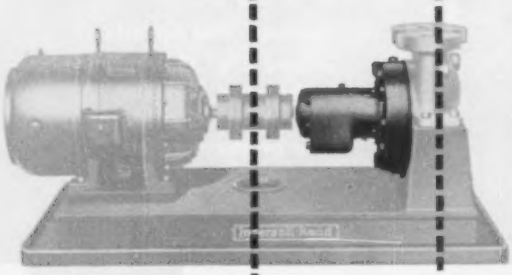
FELKER BROTHERS MANUFACTURING CO.
PHONES 230-231 MARSHFIELD, WIS.



This "multi-process" pump now handles a wider range of applications with unequalled interchangeability of parts







Here's how Ingersoll-Rand "tailors" its SFL line of heavy-duty pumps to meet your process requirements at least cost:

SFL . . . high-temperature service up to 800°F.
This is the basic water-cooled heavy-duty pump which has gained industry-wide acceptance for ruggedness and long-term dependability. It is designed specifically for hot-liquid services and is available with packed box or mechanical seals.

SFLM . . . medium temperature up to 300°F.
Take away the water-jacketing from the SFL and you have the SFLM . . . the same rugged pump *at a lower first cost*, designed for medium-temperature service. Should you later decide to put this pump on high-temperature service, *you can easily convert it to water-cooled operation*. Simply change to a water-cooled stuffing box extension and bearing housing. Available with packed box or mechanical seal.

SFLA . . . up to 200°F . . . with built-in mechanical shaft seal as standard equipment.
The seal eliminates packing maintenance and permits complete enclosure of the seal box . . . a definite safety factor. Within its rating, the SFLA is the most economical selection with single mechanical seal.

3 designs for one basic pump... all available with top or end suction for heads to 750 ft, capacities to 900 gpm

WITH Ingersoll-Rand's newly extended line of "multi-process" pumps, you can now select from three basic types . . . and get exactly the pump you want for each specific application. You get maximum interchangeability of parts, plus the first-cost economy which results from a basically *standard* production model.

Whether your process can be best served by one of these "multi-process" pumps or by other models manufactured by Ingersoll-Rand, you can be sure that your I-R pump specialist will give you objective, expert counsel. Ingersoll-Rand makes *the most complete line of centrifugal pumps* available for the process industries.

Ingersoll-Rand

10-860 11 Broadway, New York 4, N. Y.

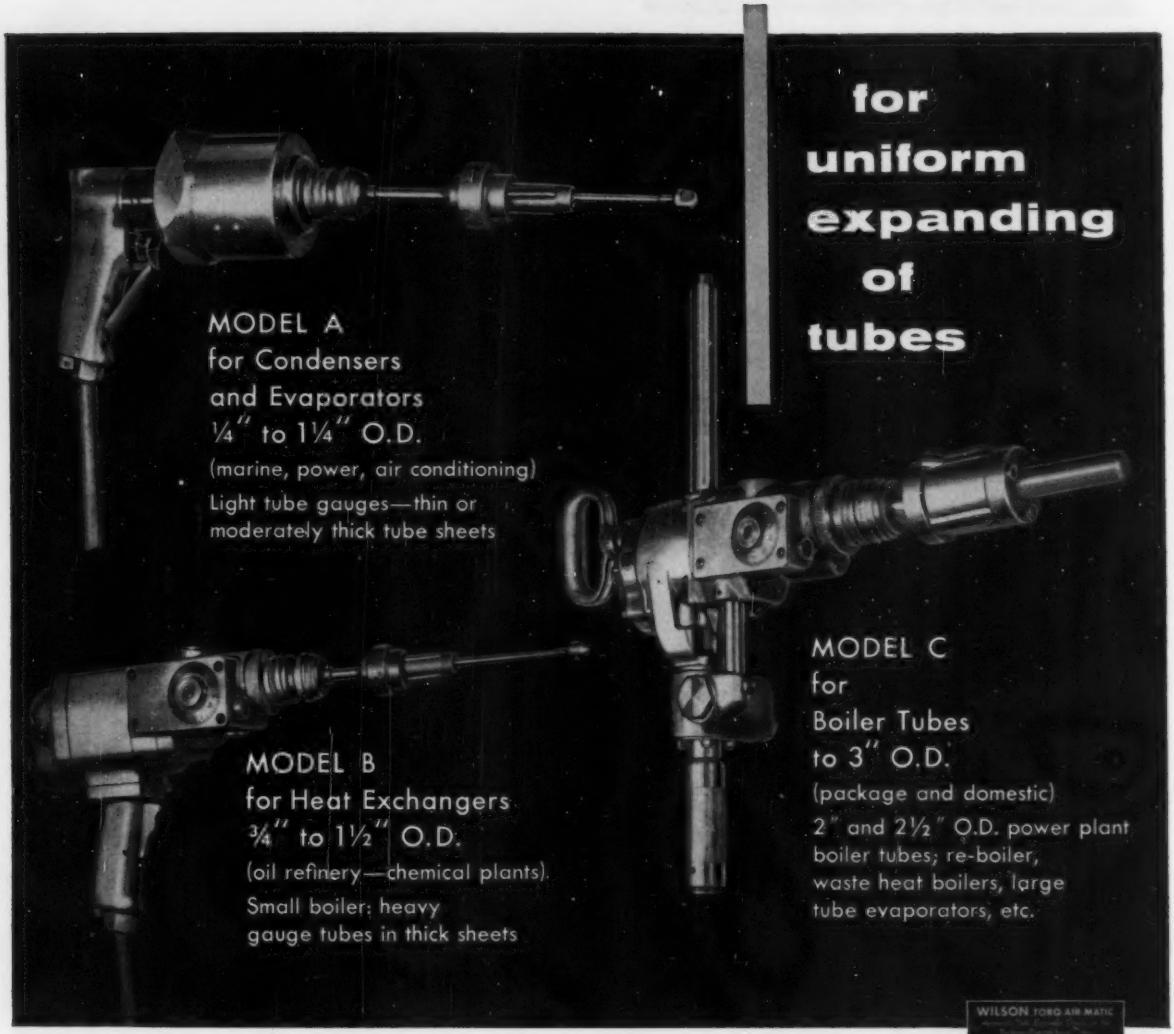
THERE'S NO SUBSTITUTE FOR EXPERIENCE IN ENGINEERED PRODUCTS

For more data on advertised products, use Readers' Service Cards, last page.

Now...for every tube...every size...every type of job

WILSON TORQ-AIR-MATIC

AUTOMATIC EXPANDER DRIVES


for uniform expanding of tubes
MODEL A
for Condensers and Evaporators
¼" to 1¼" O.D.
(marine, power, air conditioning)
Light tube gauges—thin or moderately thick tube sheets
MODEL B
for Heat Exchangers
¾" to 1½" O.D.
(oil refinery—chemical plants)
Small boiler: heavy gauge tubes in thick sheets
MODEL C
for
Boiler Tubes
to 3" O.D.
(package and domestic)
2" and 2½" O.D. power plant boiler tubes; re-boiler, waste heat boilers, large tube evaporators, etc.

Now WILSON offers a complete line of Torq-Air-Matic automatic tube expander controls. The Wilson Torq-Air-Matic is the first and only air driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel without depending on frictional, ratcheting, magnetic, hydraulic or electrical devices.

THOMAS C. WILSON, INC. 21-11 44th Ave., Long Island City 1, N. Y.
Branch Office: Land Title Building, Philadelphia 10, Pa.
Representatives in principal cities • Cable Address: "Tubeclean," New York

See how the exclusive design features of WILSON Torq-Air-Matic can help you expand tubes accurately and uniformly with considerable savings in time and manpower. Write for your Bulletin No. 581 which gives helpful data.

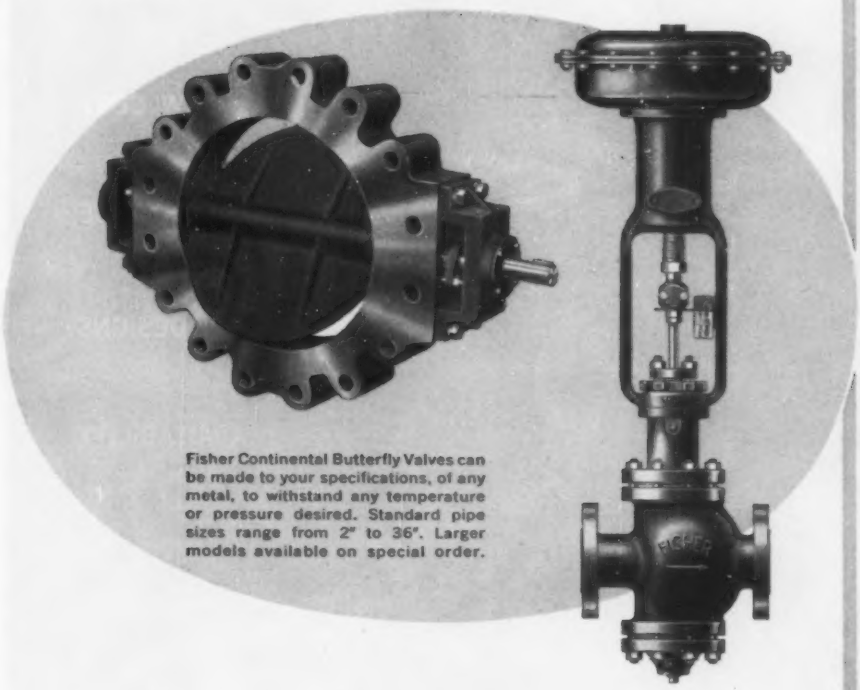
TW-887

WILSON

TUBE CLEANERS • TUBE EXPANDERS

NOW FISHER GOVERNOR
PLUS CONTINENTAL EQUIPMENT

an addition that multiplies Fisher's service to industry



Fisher Continental Butterfly Valves can be made to your specifications, of any metal, to withstand any temperature or pressure desired. Standard pipe sizes range from 2" to 36". Larger models available on special order.

With the acquisition of Continental Equipment, Fisher Governor Company is able to expand its service and product offering to its customers.

Continental Butterfly Valves are now available through the Fisher representatives listed at right.

THESE FISHER REPRESENTATIVES CAN SUPPLY YOU WITH CONTINENTAL BUTTERFLY VALVES

AMARILLO
Vinson Supply Company
ATLANTA
J. M. Smither & Company
BALTIMORE
The Rhodes Controls Company
BIRMINGHAM
Joseph W. Eshelman & Company
BUFFALO
W. J. Sommers Company
CALGARY-EDMONTON
Barber Engineering & Supply Company
CARACAS, VENEZUELA
Sinclair Spence
CHARLOTTE
Robert E. Mason & Company
CHICAGO
General Meters & Controls Company
CINCINNATI
H. T. Porter Company
CLEVELAND
A. E. Ehrke & Company
DALLAS
Vinson Supply Company
DENVER
Joy & Cox, Inc.
DETROIT
DuBois-Webb Company
HOUSTON-CORPUS CHRISTI
Puffer-Sweiven Company
INDIANAPOLIS
Acme Engineering Agency
KANSAS CITY
Sullivan-Mears Company
LOS ANGELES
B. R. Jones & Company
LOUISVILLE
Allan K. Cook Company
MARSHALLTOWN
R. S. Stover Company
MEMPHIS
Johnson & Scott
MEXICO, D. F.
Babcock & Wilcox de Mexico
MILWAUKEE
W. D. Ehrke & Company
MINNEAPOLIS
R. G. Read & Company
MONTREAL
Process & Steam Specialties, Inc.
NEW ORLEANS-LAFAYETTE
John H. Carter Company
NEW YORK
Crabbe & Stebbins Company
ODESSA-FARMINGTON
Vinson Supply Company
PHILADELPHIA
Clifford B. Ives & Company
PHOENIX
Cone & Wallace Company
PITTSBURGH
J. G. Chilcoat & Company
PORTLAND
R. H. Brown & Company
RICHMOND
W. H. Kidd Company
ST. LOUIS
H. D. Hale & Company
SALT LAKE CITY
Williams, Gritton & Wilde
SAN FRANCISCO
George M. Friederich & Company
SAN JUAN, PUERTO RICO
Badrena & Perez, Inc.
SEATTLE
Power & Controls, Inc.
SHREVEPORT
John H. Carter Company
TORONTO
George W. Beecroft & Company
TULSA
Vinson Supply Company
VANCOUVER, B. C.
Northern Columbia Process Equipment Co.
WICHITA-LIBERAL
Sullivan-Mears Company
WINNIPEG
Mechanical Valve & Engineering Spec.

If it flows through pipe anywhere in the world . . . chances are it's controlled by . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

CONTINENTAL

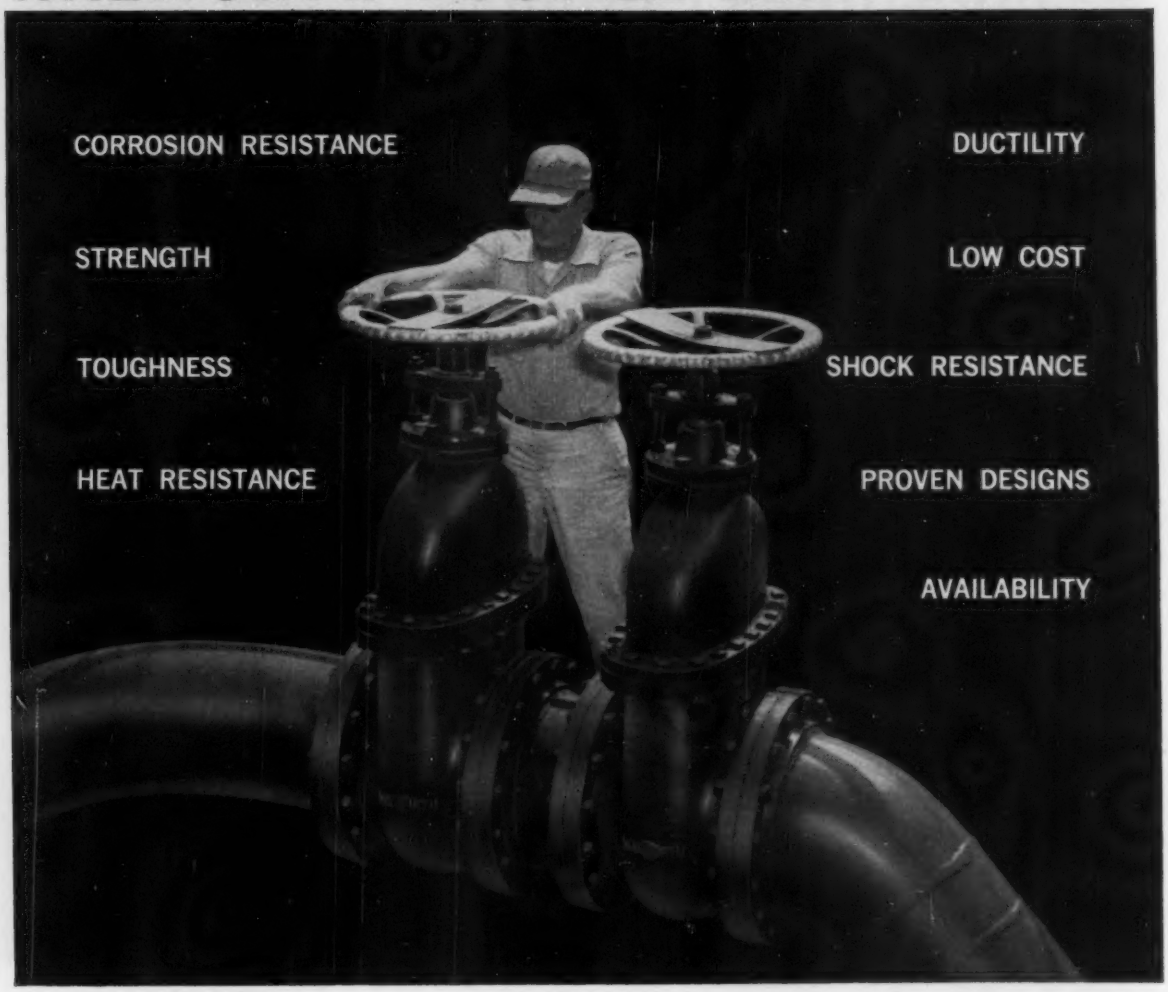
FISHER® Controls

SINCE 1880

For more data on advertised products, use Readers' Service Cards, last page.

In oil movement and storage you get all these advantages with

WALWORTH DUCTILE IRON VALVES



Walworth ductile iron valves give you – at low cost – corrosion resistance comparable to gray cast iron . . . strength approaching that of carbon steel . . . long life expectancy and minimum maintenance. Proven shock resistance . . . Walworth ductile iron valves have functioned satisfactorily after being heated to 1350°F and suddenly quenched.

When you buy Walworth ductile iron valves you get the benefit of Walworth's proven engineering and designs. Sizes ⅛ to 24 inches, screwed or flanged ends, OS&Y and NRS types.

For your copy of the new circular on ductile iron valves, contact your local Walworth distributor, or, write Walworth direct.

WALWORTH

750 THIRD AVENUE, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

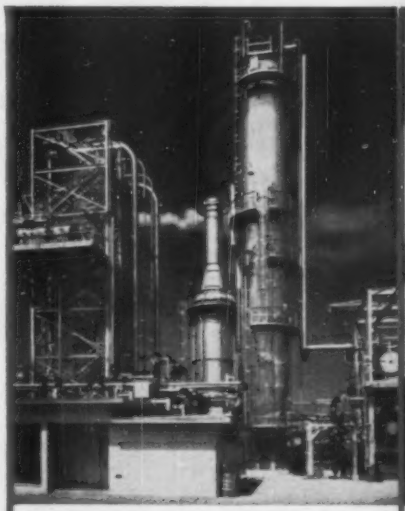
WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

How Blaw-Knox provides a complete service for every phase of petroleum processing

Backed by extensive engineering and construction experience in all phases of the petroleum industry, Blaw-Knox provides an integrated program for projects of varying size and scope.

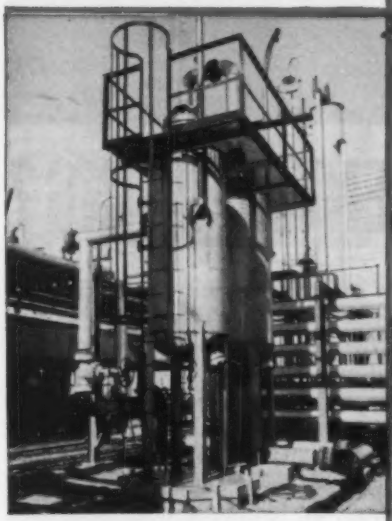
Design and development facilities include: Plant site surveys • Process engineering • Equipment procurement • Cost control reports • Complete construction • Initial operation

We shall be glad to explore any processing problem, new plant plans or modernization program that you are considering.

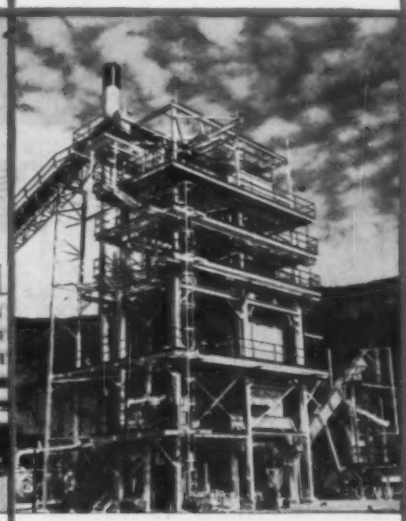


Decarbonizing unit, an exclusive Blaw-Knox development for increasing coking efficiency, lowering costs and improving basic processing procedures.

Alkylation—using sulfuric acid or hydrofluoric acid is one of the many modern intermediate processes supplied by Blaw-Knox.



The world's first Unifining unit, built by Blaw-Knox, improves distillate feed stocks and boosts quality in the product finishing segment of the industry.



This shale retorting plant demonstrates Blaw-Knox leadership in developing future oil sources as well as improving today's processing techniques.

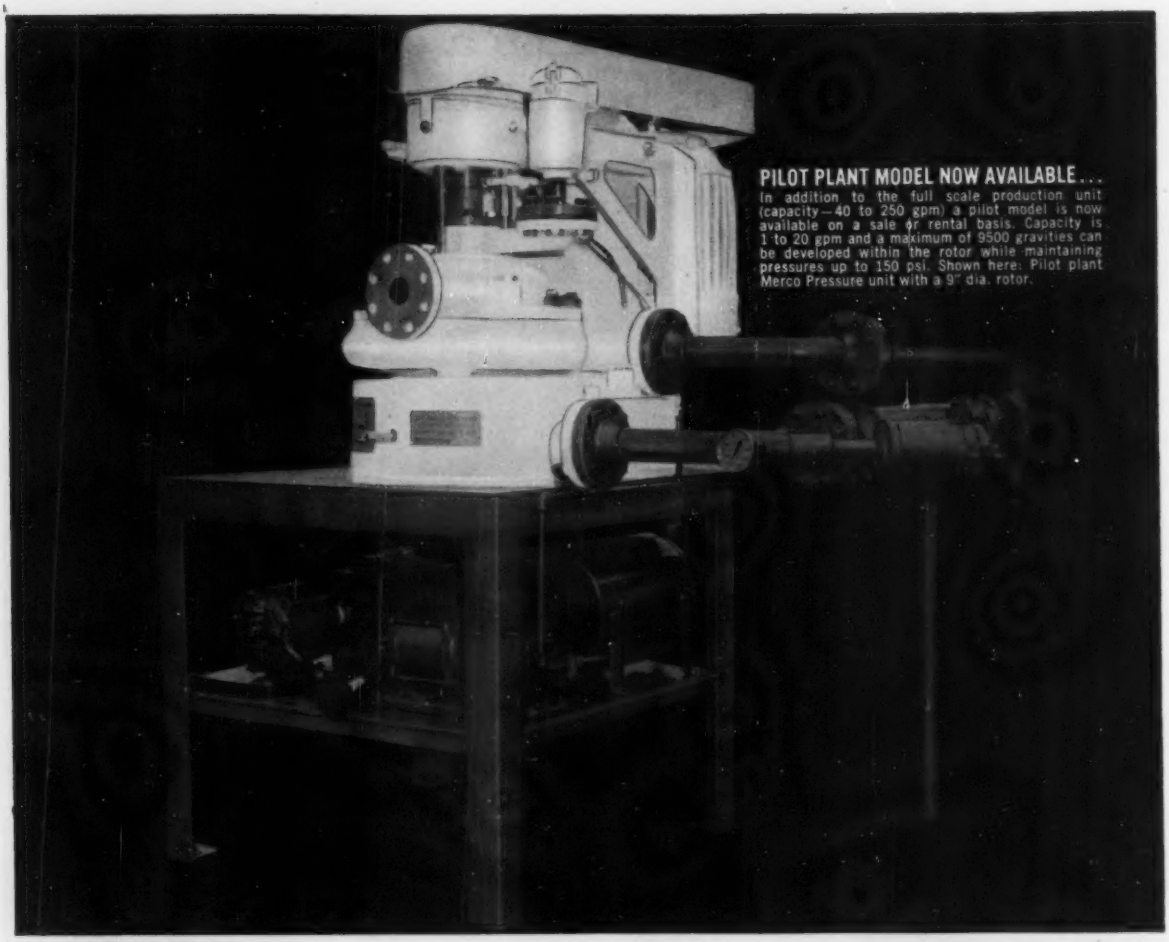
For more information, send for Bulletin 2547, "Petroleum Processing Plants." It describes Blaw-Knox services and reviews results achieved for the industry.

Blaw-Knox Company, Chemical Plants Division with production offices in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, N. J., Birmingham, Washington, D. C., and San Francisco.

BLAW-KNOX

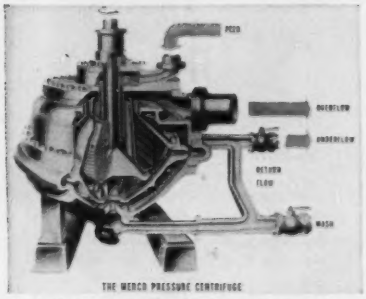
For plants of distinction . . .

For more data on advertised products, use Readers' Service Cards, last page.



PILOT PLANT MODEL NOW AVAILABLE...
In addition to the full scale production unit (capacity—40 to 250 gpm) a pilot model is now available on a sale or rental basis. Capacity is 1 to 20 gpm and a maximum of 9500 gravities can be developed within the rotor while maintaining pressures up to 150 psi. Shown here: Pilot plant Merco Pressure unit with a 9" dia. rotor.

INTERESTED IN PRESSURE CENTRIFUGING?



Illustrative drawing of a full scale Merco Pressure Centrifuge with a 30" dia. rotor bowl.

Latest addition to the Merco line of centrifugal equipment is the new Pressure Centrifuge. Originally developed for a catalyst removal step in the production of linear polyethylene, this new unit shows definite promise in a variety of refining and petrochemical applications.

Incorporating the unique return flow principle, this Merco can concentrate, wash, clarify, classify and recover soluble values . . . all at pressures up to 150 psi. There is no nozzle clogging nor solids build-up within the unit. The overhead drive eliminates the need for a submerged bearing; and a built-in, hydraulic hoist simplifies inspection and maintenance.

If there's a step in your flowsheet where centrifuging fits in and where pressure or vapor tight conditions must be maintained, you'll want new Bulletin No. 2600. Write for a copy to Dorr-Oliver Incorporated, Stamford, Connecticut.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U. S. A.

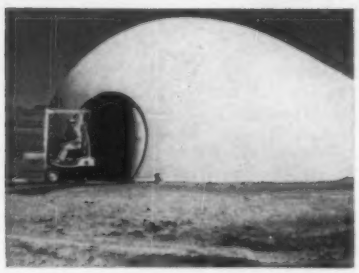
DU PONT *Petroleum Chemicals* NEWS

Number 91 in a Series of Bulletins for the Petroleum Industry

SEPTEMBER 1958

Additives double the life of diesel fuel filters in earth-moving equipment

Air-supported nylon warehouses solve storage problems for oil marketers



Low cost and easy portability are the chief advantages of air-supported warehouses like the one pictured here.

Such structures provide ideal storage shelter for petroleum products in drums, and TBA items. The cost can be as little as one-tenth that of the same-sized structure built of conventional materials. When deflated, the entire building can be transported in a station wagon. Only a couple of hours are required to erect the air-supported structure of average size. And the entire job can be done by two men.

Made from oil

Another important feature of the air-supported warehouse which is of particular interest to oil men is that it is made of petroleum-based nylon.

Nylon is a typical example of the many new products which the chemical industry is developing from petroleum. And the Du Pont Company is one of the leaders in the development of oil-based chemical products.

CUT DOWNTIME IN HALF

Five recent months of field and laboratory tests put new light on filter performance in automotive diesel equipment.

The first field testing phase determined the "hours to plugging" of secondary filters in earth-movers operating on fuel which had *not* been treated with Du Pont additives. These were the commonly used resin-impregnated paper filters with a porosity of approximately two microns . . . filters known to afford excellent protection for fuel-injection units.

FILTERS WERE CONTINUALLY CHECKED throughout the test. Paul Richard, Du Pont representative and automotive specialist, is shown at left discussing filter-plugging problems with one of the diesel operators.

In the second phase, Du Pont Fuel Oil Additive No. 2 (FOA-2) and Du Pont Metal Deactivator (DMD) were added to the test fuel. *Filter life*, on the average, *was doubled*.

This means, of course, that only half as many filters were required, and that costly downtime for emergency servicing in the field, and filter replacement, was cut in half.

Insoluble residue reduced

FOA-2/DMD combinations reduce the amount of insoluble residue which nor-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DUPONT *Petroleum Chemicals* NEWS

NEW MID-CONTINENT REGIONAL MANAGER

WILLIAM W. WINGATE has been promoted to manager of the DuPont Petroleum Chemicals Division's Mid-Continent region, with headquarters in Tulsa, Oklahoma.

He was formerly assistant manager of this region. Previously Bill had been active in regional sales and technical service work on all DuPont additives other than tetraethyl lead. This includes DuPont Metal Deactivator, lube and fuel oil additives, antioxidants, dyes and grease stabilizers.

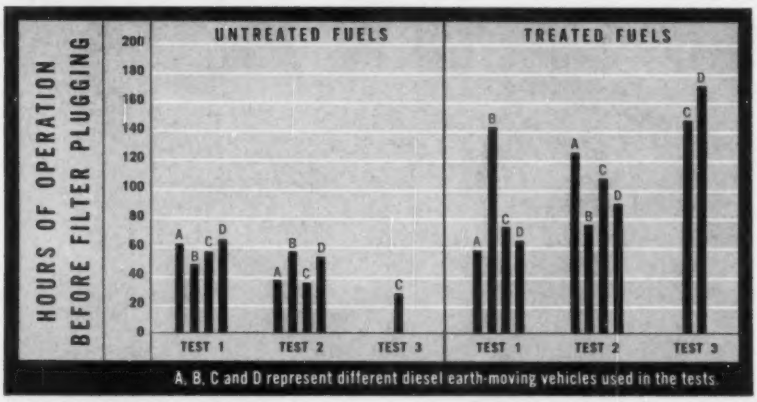
Bill Wingate had an early introduction to the oil industry doing gasoline and lube oil testing for a major oil company while earning his B.S. degree in chemical engineering at the University of Pennsylvania.

During World War II, Wingate was a lieutenant in the Navy and spent three years on submarine duty with the Pacific Fleet.

He is a member of Sigma Xi and Tau Beta Pi.

WILLIAM W. WINGATE

CONTINUED *Additives double filter life*



A, B, C and D represent different diesel earth-moving vehicles used in the tests.

mally forms in a fuel during storage or recirculation in an engine fuel system. FOA-2 acts also as a solubilizer and dispersant of sludge formations, and will prevent injector sticking and filter fouling. DMD retards the formation of copper mercaptide gel as well as combatting the adverse catalytic effect of copper-bearing metals in a system.

More flexible processing

By using FOA-2, you can balance stocks to meet varying market demands, because it stabilizes fuel during storage. You can stabilize cat-cracked distillates or blends with straight-run stocks. And you can improve residuals, too.

Test your own stocks

It's easy to test FOA-2 and DMD in your own stocks.

Samples and technical information are available from your DuPont Petroleum Chemicals Division technical representative. Contact him for further details.

Petroleum Lab being expanded

A large construction project, expansion of the product development and technical service facilities at the DuPont Petroleum Laboratory, is now under way. Completion is planned for mid-'59.

The project includes the addition of two new wings to the main laboratory building, to house new chemical and engineering apparatus for development and performance testing of chemical additives for petroleum products.

New facilities for the Petroleum Chemicals Division's Road Test Laboratory also are a part of the project.

New aluminum engine to test additive performance

Looking toward future trends in the automotive industry, the DuPont Petroleum Laboratory has installed an all-aluminum test engine to check performance of fuels and lubricants in lightweight power plants.

The new unit, a four-cylinder engine duplicating a companion test engine of conventional cast iron and steel, will provide comparative performance and combustion data for the petroleum and automotive industries. It will also assist in the laboratory's development of new products to meet lightweight engine requirements. The engine will be of particular value in analyzing the performance of refinery stocks that might be used in blending future fuels.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630
Cleveland 15—25 Prospect Ave. . . . SUperior 1-1363
Houston 2—
705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 4-1354
New York 20—
45 Rockefeller Plaza . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . EXbrook 2-1934
Seattle 3—4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—DuPont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
In Other Countries—Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., PRospect 4-2962.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

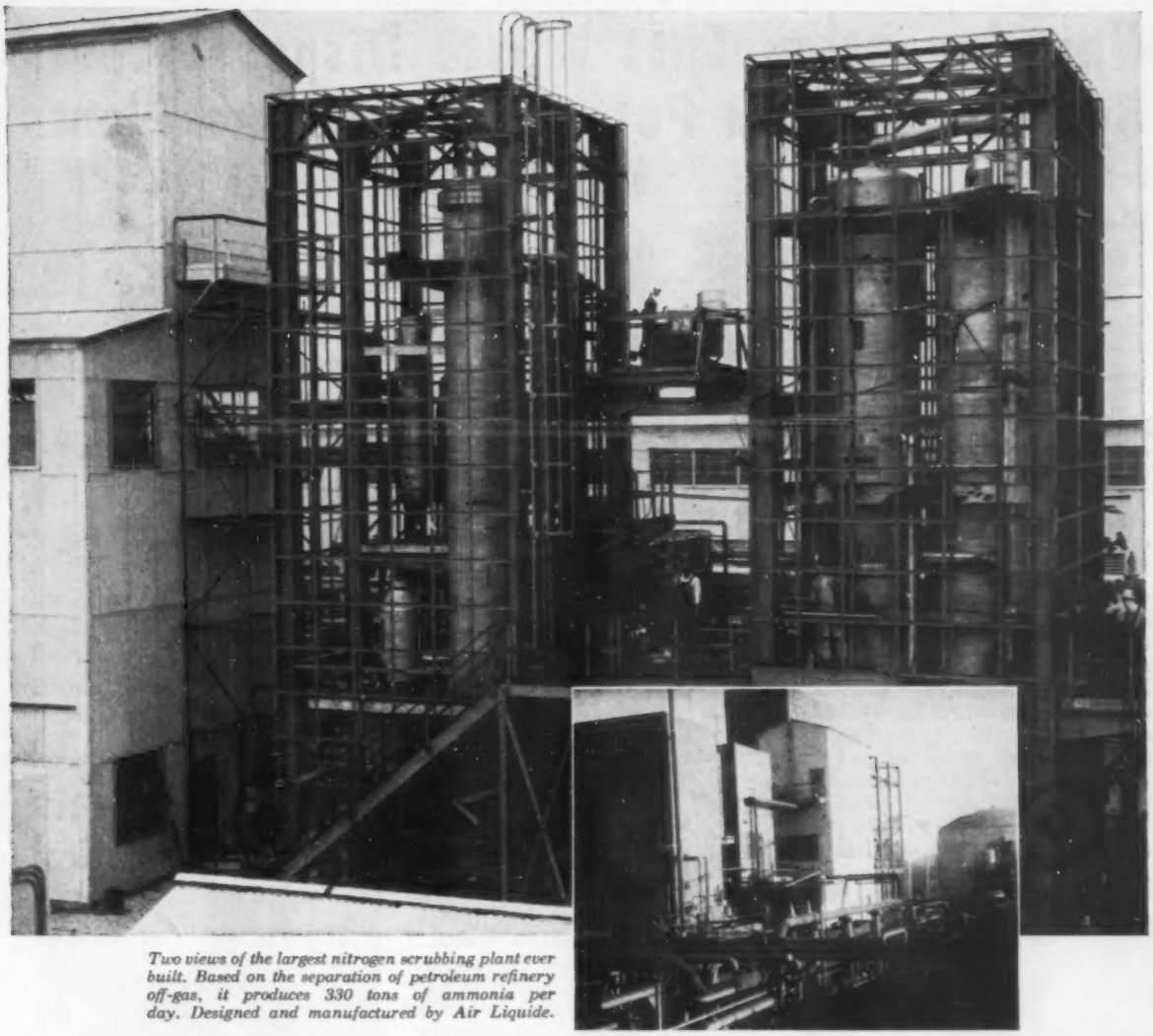
Du Pont Tetraethyl Lead and other Petroleum Additives

OVER

A-7720

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

Printed in U. S. A.



Two views of the largest nitrogen scrubbing plant ever built. Based on the separation of petroleum refinery off-gas, it produces 330 tons of ammonia per day. Designed and manufactured by Air Liquide.

A *complete* low-temperature service by AIR LIQUIDE

★ *Process Engineering of Complete Plants and of Custom-Designed Equipment*
★ *Technical Consultation for Special Requirements*
★ *Manufacturing of Plants and Equipment*
★ *Plant Erection and Start-Up Supervision*

American Air Liquide places at your disposal the wide experience of research, engineering and manufacturing staffs backed by a half century of "know-how" in the specialized field of low-temperature separation of gaseous mixtures, in North America and throughout the world.

If your present or contemplated operations include the use or production of oxygen, nitrogen, argon, hydrogen, carbon monoxide, methane, ethylene, etc., involving such mixtures as atmospheric air, natural gas, refinery off-gases, coke-oven gases or similar mixtures, our low-temperature technology and plants can meet your requirements.

Some idea of the scope and widespread use of our low-temperature plants is indicated by the fact that in North America alone, every day, more than 2000 tons of oxygen and 2000 tons of ammonia synthesis mixture are being produced in American Air Liquide designed plants.

We shall be pleased to consult with you on the application of Air Liquide processes and equipment to your particular needs.

Write or call us at 405 Lexington Ave., New York 17, N.Y. Telephone: YUkon 6-6544. In Canada: L'Air Liquide, 1111 Beaver Hall Hill, Montreal, Que. Telephone: UNiversity 6-4781.

Here are some of the types of plants we have designed and built:

- *Air Separation — oxygen, nitrogen, etc.*
- *Tonnage Oxygen and Nitrogen (Gas and Liquid)*
- *Rare Gases Recovery*
- *Coke-Oven Gas Separation*
- *Refinery Gas Separation*
- *CO_2 Purification*
- *Methane Purification*
- *Natural Gas Liquefaction*
- *Pure CO_2 Production*
- *Heavy Water — for Atomic Reactors*
- *Hydrogen Liquefaction*
- *Helium Recovery*

AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE — NEWEST IN DESIGN

405 LEXINGTON AVE., NEW YORK 17, N.Y.

In Canada: L'AIR LIQUIDE. 1111 Beaver Hall Hill, Montreal, Que.

For more data on advertised products, use Readers' Service Cards, last page.

New Invention Cuts Waste Disposal Costs By Two-Thirds in Petroleum Products Plants

Industry Cost Averages May Be Lowered Soon

If your plant is average, you're probably spending between .55 and .85 cents for every cubic yard of waste or trash moved to the disposal area . . . not including truck operation costs.

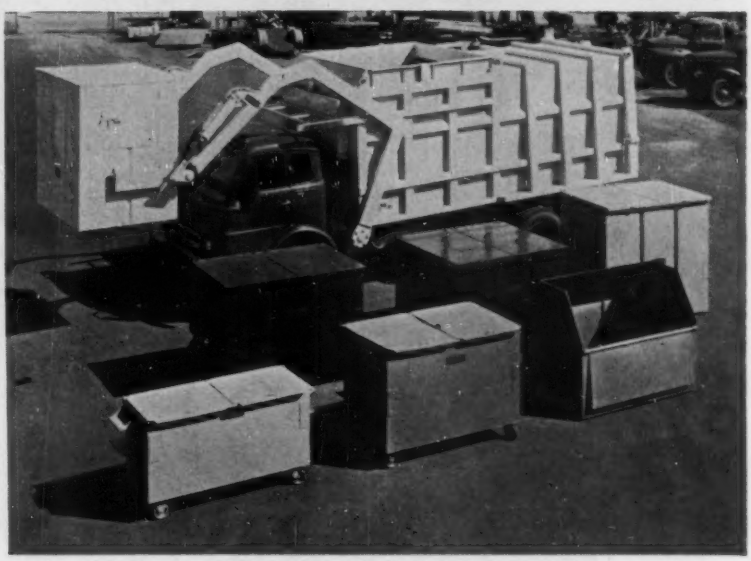
A recent development, the DEMPSTER-DUMPMASTER self-loading packer, promises to cut direct disposal costs to a new industry low of .07 to .16 cents per cubic yard for volume producers.

This new approach is an extension of the widely-established DEMPSTER-DUMPSTER System, in that it employs detachable waste storage containers. However, instead of carrying each container to the disposal area for dumping, the new machine empties many containers into its body, where the material is compacted to a fraction of its former volume. This permits per-trip payloads of 50 to 100 cubic yards of loose material, depending on its characteristics.

Multiple exposure photo shows dumping of 6 cu. yd. container.

How it Operates

The one-man Dumpmaster makes its rounds from container to container. Approaching, the driver engages lifting channels on the container's sides with the clearance arms. From controls in the cab, or remote controls at the front bumper, the container is lifted and rotated, discharging waste into the packer body. The material is hydraulically compacted while enroute to the next location. Containers may also be handled from docks or below grade. The safety clearance arms never pass the cab windows, eliminating possibility of driver injury.



The newly developed DEMPSTER-DUMPMASTER is shown with the seven basic containers it serves. Being hoisted is a 6 cu. yd. model. On ground are 1, 2, 3, 4 and 5 cu. yd. designs. Open container is used for hand-loading service.

New "Tracking" Caster Developments Make Plant "Container Trains" Practical

To whip the high cost of moving refuse outside, many plants are going to "container trains." Using special casters and couplers, eight to ten containers are towed by "plant mules" to inside generation points where an empty is dropped off and the full one is coupled on. Outside, the containers are uncoupled and automatically emptied by the waiting DUMPMASTER.

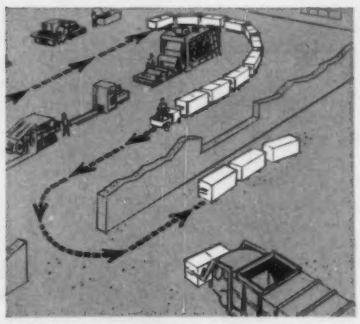


Diagram shows containers, in train, being hauled outside for emptying.

* * *

Many Designs Available

Standard and special-purpose containers, ranging from one through six cubic yard capacity, with or without casters, are available. The two cubic yard container above holds the equivalent of over 12 30-gallon trash cans.

Cost-Finding Book Offered

Write for the free 40-page book, "How to Cut Waste Disposal Costs," offered by the manufacturer. It contains cost-finding formulas, solutions to problems, case histories, industry average costs, etc. Equipment demonstrations arranged on request.

Mfd. by Dempster Brothers, Inc.

DEMPSTER BROTHERS

KNOXVILLE, TENN., DEPT. PR-9

Resilient and "Corrosion-proof" Garlock Gaskets

Teflon* JACKETED GASKETS for glass pipe flanges etc.

Resilience and deformability that are lacking in solid all-TEFLON gaskets are amply provided in Garlock TEFLON-jacketed gaskets. Fillers are available in practically any material for any application. Once the basic design has been selected, then the filler material and thickness are considered: rubber, asbestos, cork, corrugated stainless steel, etc. Call your Garlock representative or write for Garlock Folder AD-154.

Gaskets of TEFLON are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. That's why your Garlock representative can give you unbiased recommendations.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
Plastics Div.: United States Gasket Co., Camden, N.J.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

BASIC DESIGNS

Slit Envelope. Flat Teflon stock slit from outside diameter to within 1/8" of inside diameter.

Milled Envelope. Flat Teflon stock machined from outside diameter to within 1/32" of inside diameter. Provides flush surface with pipe I.D. Reduces impedance to process flow.

Formed Shield for large diameters and irregular opening such as elliptical manholes.

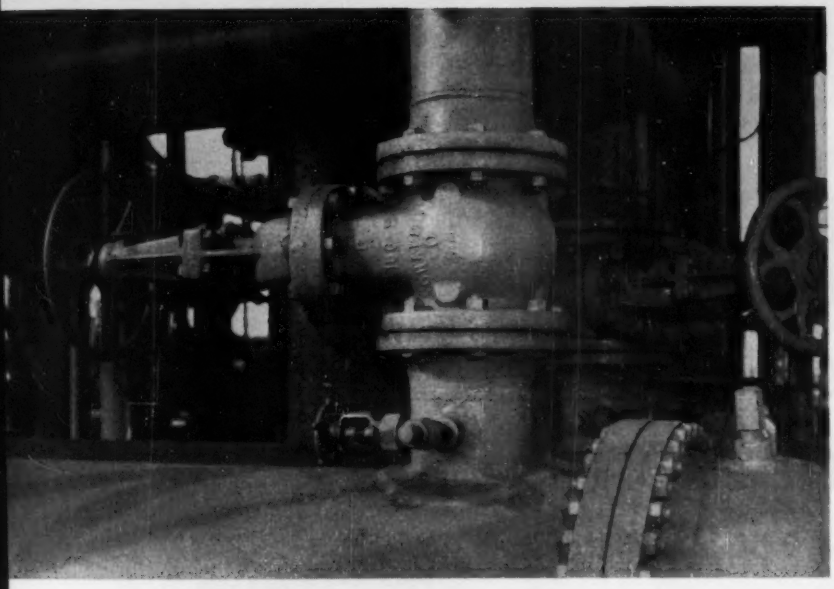
Double Jacket. Two jackets overlapping to protect O.D. as well as I.D. For glass-lined steel nozzles.

GARLOCK

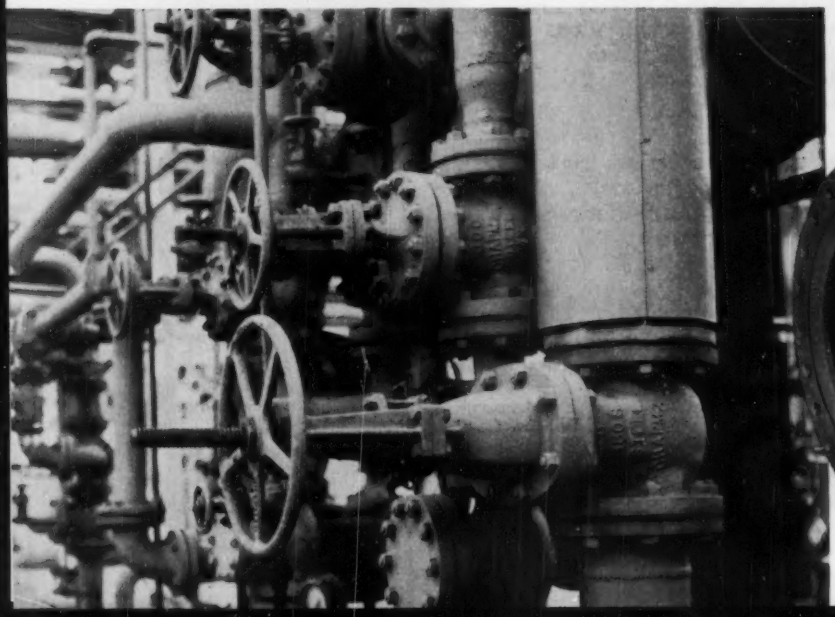
Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

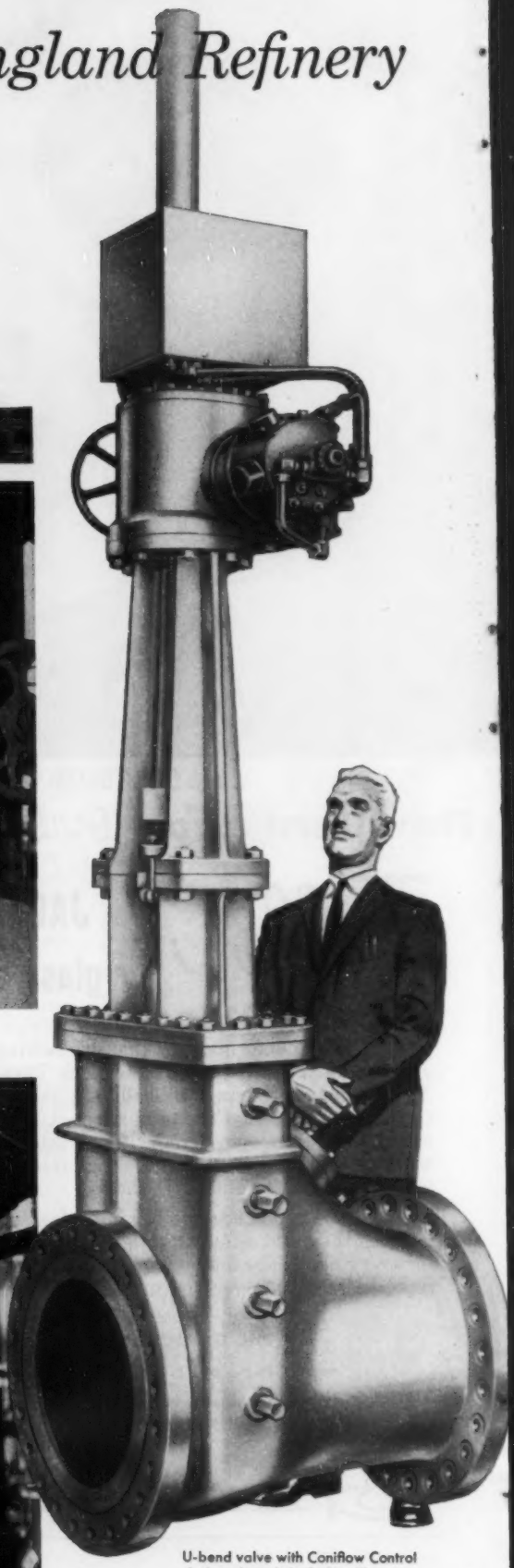
*Du Pont Trademark

New England Refinery



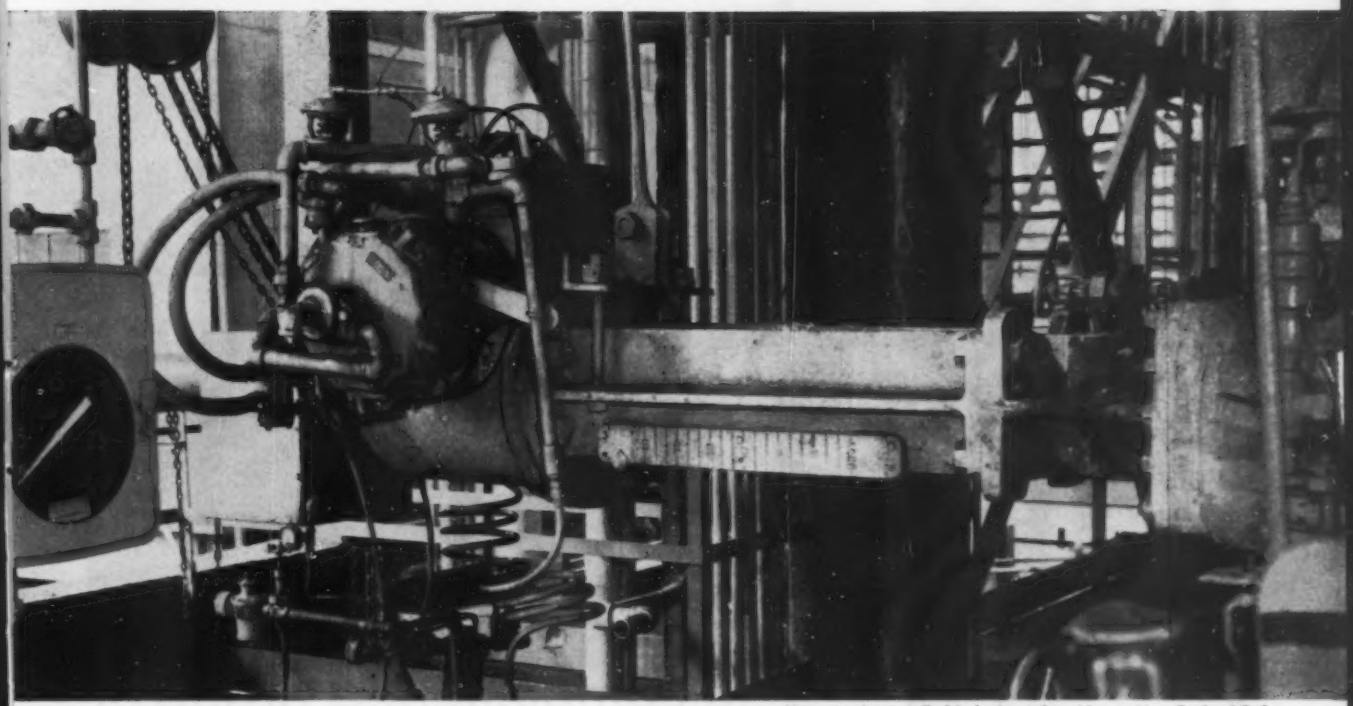
Above and below, some of many Chapman Valves giving service at New England Refinery at Everett.





U-bend valve with Coniflow Control designed and built by Chapman for catalytic cracking service.

uses **CHAPMAN VALVES**



U-bend valve installed in horizontal position at New England Refinery.

This isn't just a regional story. Far from it. In addition to the New England Refinery in Everett, Massachusetts, the Esso Standard Oil Company has other refineries at Linden, New Jersey; Bayonne, New Jersey; Baltimore, Maryland; Baton Rouge, Louisiana and Charleston, South Carolina.

These, like other leading refineries in all parts of the world, use Chapman Valves . . . both standard and special . . . *for good reasons.*

Chapman has all the engineering and manufacturing facilities to think out and work out valves that will fully meet the requirements of today and, just as important, to meet tomorrow's requirements.

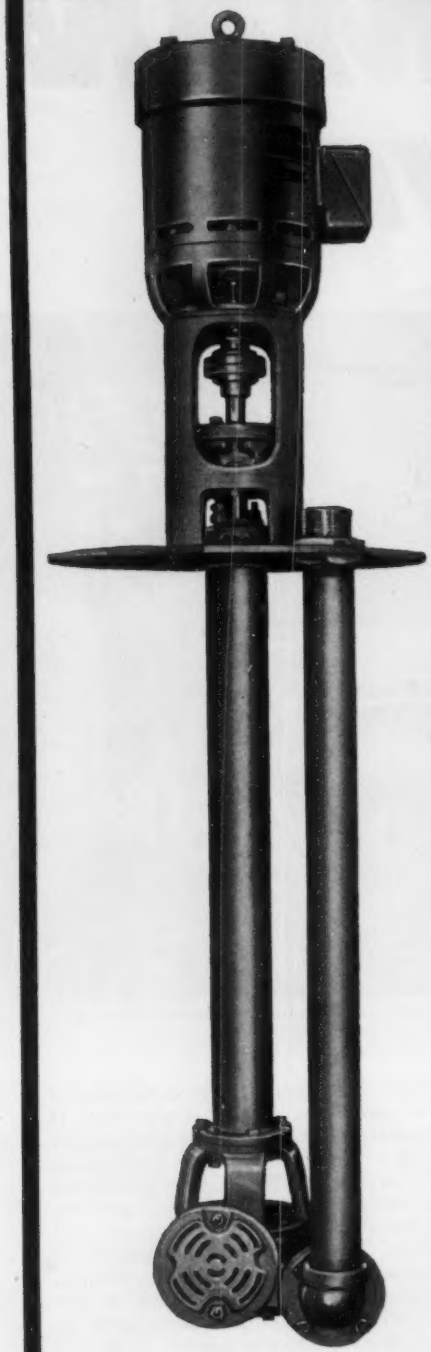
Esso's New England Refinery is a good example of meeting these requirements. When World War II brought on an urgent demand for better and cheaper gasoline and fuel, a new method . . . catalytic cracking . . . was developed. Today, with this added miraculous giant known as a "cat cracker," built by Foster Wheeler, the New England Refinery is a still more modern plant. Tanks with a total capacity of 60,000,000 gallons can be filled with finished products. Some of this production is delivered to all of New England and to parts of New York State to meet industrial, automotive and domestic needs . . . a real, important service.

The **CHAPMAN** *Valve Manufacturing Co.*

INDIAN ORCHARD, MASSACHUSETTS

It pays to talk about your valve requirements for today and tomorrow with Chapman. The Chapman Valve Manufacturing Company has the men, the brains and the facilities to meet these requirements fully, no matter how tough they are. Chapman has the engineers, metallurgists, experience, and manufacturing capacity to produce the valves you need. Write, and we'll gladly consult with you.

for catalytic cracking service.

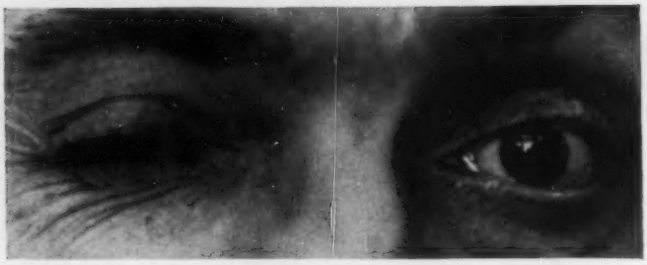


GOULDS

PUMPS FOR INDUSTRY

new way to pump corrosives

ANNOUNCING



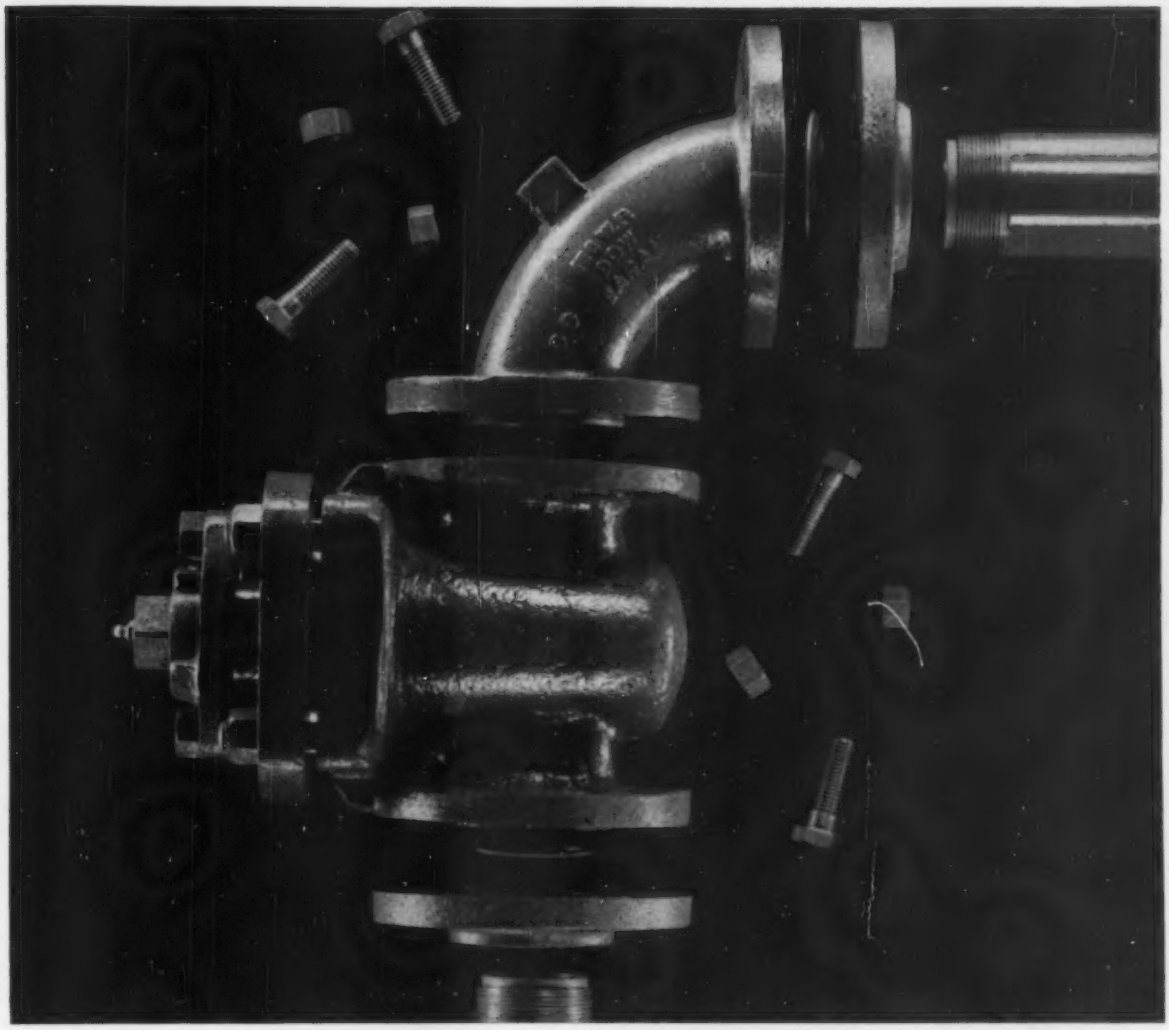
a complete new group of vertical process pumps

How often would a vertical pump be just the ticket for transfer or other service . . . *except for the fact that you're handling a corrosive liquid?*

Now you can choose from a complete line of vertical process pumps especially built for heavy-duty service, pumping corrosive liquids. Goulds now offers a wide range of vertical pumps in highly corrosive-resistant materials.

Special constructions available. Standard construction of Goulds new vertical process pumps is 316 stainless steel . . . and other materials to meet your requirements are available on application.

Free bulletin. To discover all the outstanding features of this new line of heavy-duty vertical pumps, contact your nearest Goulds representative and ask for a free copy of Bulletin No. 727-1. Or write to Dept. PR-98, Goulds Pumps, Inc., Seneca Falls, N. Y.



You can see why Saran lined pipe cuts operating costs

These corrosion-resistant pipes, fittings and valves are stock items, and they can be fabricated in the field

The long range economy of Saran lined pipe starts right here—with the immediate availability of pipe, fittings and valves . . . as stock items. There's no waiting . . . no price premium to pay.

And Saran lined pipe can be fabricated in the field. Only conventional hand tools or power equipment are needed to cut and thread it right on the job site.

Saran lined pipe pays off through the years with superior corrosion resistance and strength. When you specify the new gray Saran lined pipe, valves, pumps and fittings, you'll be able to pipe commonly used acids, alkalies and other corrosive liquids under a wider temperature range.

You can plan a *complete* corrosion-free pipe system with Saran lined pipe, valves, pumps and fittings. They're available for systems operating from full vacuum up to 300 psi and temperatures from −20° F to 200° F. Send the coupon today for further information. And be sure to ask about Saraloy® 898 tank lining, too. THE DOW CHEMICAL COMPANY, Midland, Michigan.

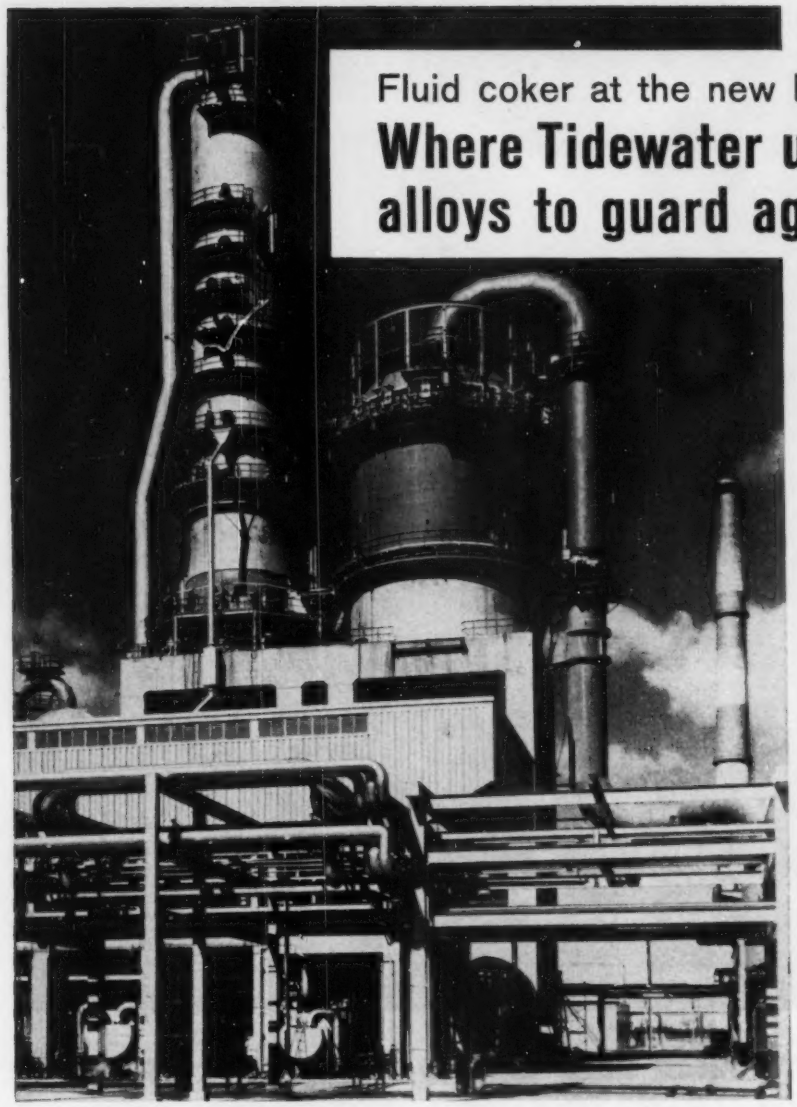
Saran Lined Pipe Company
Dept. 2002F-1
2415 Burdette Avenue
Ferndale 20, Michigan

Please send me information on: ☐ Saran lined pipe, fittings and valves ☐ Saran lined centrifugal pumps ☐ Saraloy 898 chemical resistant sheeting

Name_____ Title_____ Company_____

Address_____ City_____ State_____

YOU CAN DEPEND ON DOW



Fluid coker at the new Delaware Refinery...

Where Tidewater uses high nickel alloys to guard against corrosion

Here's the fluid coker at the Tidewater Oil Company's new Delaware Refinery, which boasts the world's largest initial capacity.

Like other units in this refinery, the fluid coker reflects latest practice in economical corrosion protection. To provide this protection, Tidewater engineers took full advantage of the properties of high nickel alloys. You'll find the details in the table below.

Throughout this ultra-modern refinery, high nickel alloys such as Monel* and Inconel* combat corrosion by mineral acids and other troublesome corrosives.

For more information, or for help with a corrosion engineering problem of your own, write Inco's Development and Research Division.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall St. New York 5, N. Y.

INCO
TRADE MARK

Schedule of Use of Monel nickel-copper alloy to combat corrosion by aqueous H_2S and HCl in fluid coker at the new Tidewater Refinery**

EQUIPMENT		LOCATION	MATERIAL
Columns:	Fractionator	Top head	Monel-clad steel
		Shell, tray #17 to top	Monel-clad steel
		Trays #17, 18, 19	Monel alloy
Vessels:	Fractionator-accumulator	Nozzles	Monel alloy
	First commingler drum	"	" "
	Second commingler drum	"	" "
	Stabilizer accumulator	"	" "
	Blowdown quench drum	"	Monel alloy
	Main water seal vessel	"	" "
	Bypass water seal vessel	"	" "
Pumps:	Foul water pump	Casing, impeller	Monel alloy
Piping:	Foul water line, accumulator to stripper		Monel alloy

*Registered trademark **Where temperatures go above 500°-550°F, nickel-containing type 316 stainless and stainless-clad steel are also extensively used in this unit.

INCO NICKEL ALLOYS

An Important First In Petroleum Literature

ADVANCES IN PETROLEUM CHEMISTRY AND REFINING

ADVISORY BOARD

C. L. **BROWN**, Mgr. of Scientific Liaison, Esso Research and Engineering Co.
E. B. **CHISWELL**, Executive Secretary, California Chemical Corp.
JACK C. **DART**, Vice-President, Houdry Process Corp.
E. L. **D'OUVILLE**, Senior Technologist, Standard Oil Company (Indiana)
T. W. **EVANS**, Vice-President, Shell Development Company
ROBERT A. **FINDLAY**, Assistant Mgr., Process Development Div., Phillips Petroleum Co.
J. L. **FRANKLIN**, Research Associate, Humble Oil & Refining Co.
VLADIMIR **HAENSEL**, Director of Refining Research, Universal Oil Co.
GEORGES **HUGEL**, Director of Fundamental Organic Research, Institut Francais du Petrole, Paris, France
E. C. **HUGHES**, Research Manager, Standard Oil Company (Ohio)
EDUARD C. **KOOYMAN**, Koninklijke/Shell Laboratorium, Amsterdam, The Netherlands
JERRY **McAFEE**, Vice-President, Gulf Oil Corp.
GEORGE R. **SCHULTZE**, Director, Institut fur Erdolforschung, Hanover, Germany
K. M. **WATSON**, Consultant, Lake Zurich, Ill.
KARL **ZIEGLER**, Director, Institut fur Kohlenforschung, Mulheim (Ruhr), Germany

Edited by: Kenneth A. Kobe and John J. McKetta, Professors of Chemical Engineering, The University of Texas

VOLUME I, 1958, 656 pages, 131 illus., 86 tables..... **Price $13.50**

The first in a series designed to record rapid advances of the petroleum and petrochemicals industry. Need for series is created by this industry's extreme diversification. To achieve this goal, the editors will, at annual intervals, present progress reports written by leading authorities. To assure coverage in depth, the editors have conceived a blueprint of the industry divided into five main sections: Economics and Future Trends, Unit Operations and Design, Refining Processes, Petrochemicals and Mechanical Equipment. Each year they will choose topics from each of the different sections and arrange them within the volume in the sequence given above.

Over several years, the Series on Advances will have touched all parts of the industry. Cumulative indices of main topics in subsequent volumes will tie the material together.

The Series has the unique characteristic of being more than a reference work of ideas and methods . . . more than an encyclopedic listing of developments and techniques. It is a means whereby you will have—within a reasonably short time—thorough, authoritative explanations and descriptions of latest practices and procedures being used in the industry. You'll have ready access to the know-how of some of the most outstanding scientists and technologists . . . men who have spent years developing new ideas and methods that can be of real interest to you.

CONTENTS (Condensed). GROUP I. Economics And Future Trends: Petroleum Operations In The U.S., *by Richard J. Gonzalez;* Present and Future Sources And Compositions, *by Harold Gershinowitz;* Fuel Trends, *by Harold A. Beatty and Wheeler G. Lovell.* **GROUP II. Unit Operations And Design:** Separation And Purification By Crystallization, *by Robert A. Findlay and John A. Weedman;* Superfractionization, Azeotropic and Extractive Distillations, *by S. B. Zdonik;* New Fractionating-Tray Designs, *by Frank J. Lockhart and C. W. Leggett.* **GROUP III. Refining Processes:** Alkylation of Paraffins, *by John O. Iverson and Louis Schmerling;* Catalytic Reforming, *by Vladimir Haensel and C. V. Berger;* Solvent Refining, *by Alfred W. Francis and William H. King.* **GROUP IV. Petrochemicals:** The Oxo Processes, *by Alexis Voorhies, Jr., John J. Owen and John F. Johnson;* Solid Polymers from Surface Catalysts, *by Herbert N. Friedlander and William Resnick.* **GROUP V. Mechanical Equipment:** Power Plants of the Future, *by C. G. A. Rosen.*

To Order Use Handy Form Below

THE GULF PUBLISHING COMPANY
P. O. Box 2608, Houston 1, Texas

Send Me: ____ Copies of Vol. I, Advances In Petroleum Chemistry And Refining, Price $13.50 a copy
____ Copies of Petroleum Refining With Chemicals,...Price $16.50 a copy
____ Copies of Petroleum Refinery Engineering,.....Price $15.00 a copy

☐ My Check Enclosed, I Save Postage ☐ Bill Me ☐ Bill My Company
☐ 10-Day Free Examination ☐ Send Free Book Catalog

Name_____ Position_____

Company_____

Address: ☐ Home ☐ Office _____

City_____ Zone_____ State_____

Orders Outside U.S. By Pro-Forma Invoice

OTHER REFINING BOOKS

PETROLEUM REFINING WITH CHEMICALS
By V. A. Kalichevsky and Kenneth A. Kobe

Comprehensive treatise on problems encountered in refining and finishing petroleum products. Provides discussions on refining of petroleum with chemicals and solvents, use of additives for improving quality of petroleum products, modern testing methods with interpretations, concept of color . . . and much more.
1958, 700 pages, Illus....Price $16.50

PETROLEUM REFINERY ENGINEERING
By W. L. Nelson

Book covers methods of processing petroleum, design of refinery equipment, evaluation of crude petroleum for yield of products, practical usefulness of petroleum products and cost of refinery equipment and its operation. A new Appendix introduces analysis of over 70 foreign crude oils as well as about 90 representative U.S. oils for comparison.
1958, 974 pages, illus....Price $15.00

THE GULF PUBLISHING COMPANY
P. O. Box 2608, Houston 1, Texas

For more data on advertised products, use Readers' Service Cards, last page.

ACTUAL SIZE

GET THE MOST FOR YOUR

BTU DOLLAR

...with Nicholson steam traps

You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment *continuously* . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity —all the time—to obtain top steam temperature where and when you need it.

Make full use of your BTU dollar, with Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre

Marsh Mastergauge

...the gauge that has everything!

LEAK-PROOF ONE-PIECE CONSTRUCTION from socket to tip of bourdon tube...accomplished by the exclusive Marsh "Conoweld" process.

STURDY "MARSHALLOY" CASE formed of boiler-plate thickness steel, copper clad inside and outside by "Marshalloy" process to give it all the durability and the corrosion resistance of solid copper with the dependable strength of steel.

SUPERLATIVE "MASTERGAUGE" MOVEMENT with exclusive "coined" sector gear, self lubricating, frictionless action and other refinements that add years to service life.

TYPES FOR EVERY SERVICE...wide range of bourdon tubes including stainless steels and monel. Full range of pressures, vacuum, compound gauges in endless sizes, case styles. Only Marsh has the "Safecase" for dangerous gauge applications.

"Mastergauge" is standard bearer for the broad line of Marsh Gauges fully covered in Catalog 76-G. All are available with the "Recalibrator" —best way to correct a gauge that has been knocked out of adjustment.

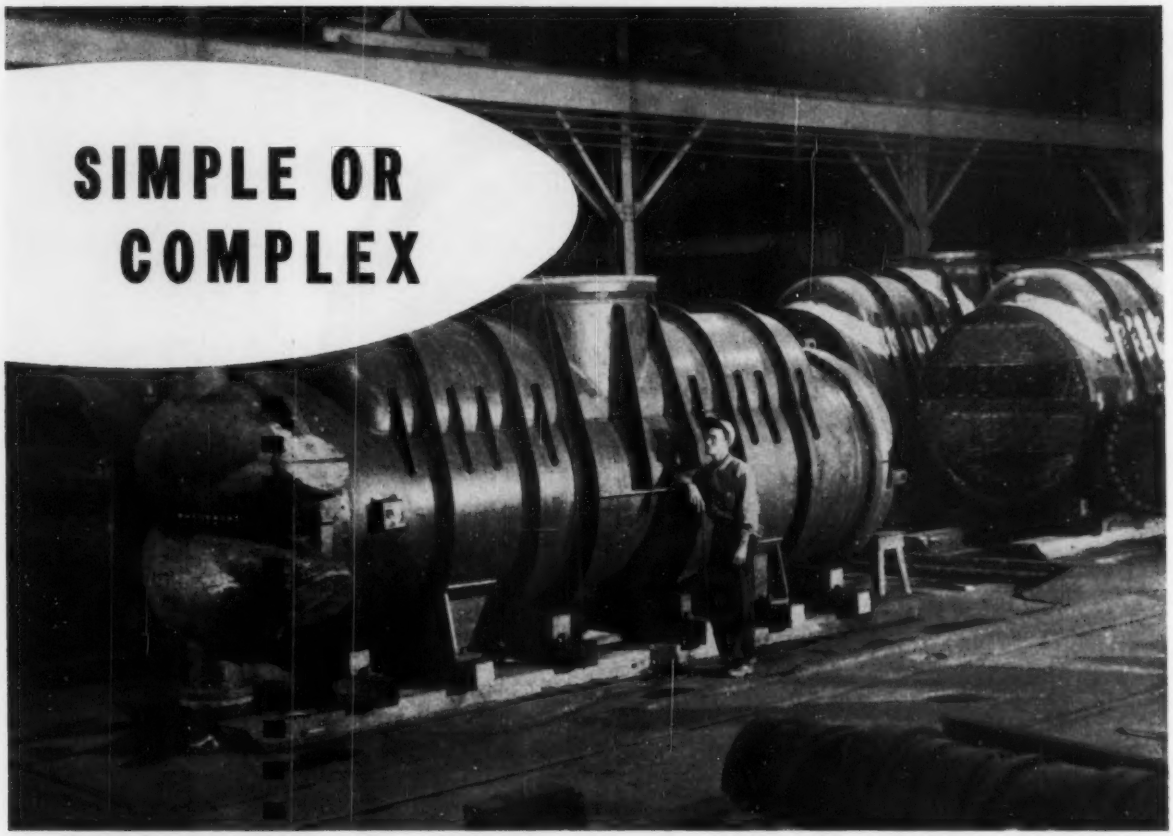
MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corp.,
Dept. R, Skokie, Illinois
Marsh Instrument & Valve Co., (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta, Canada

MARSH

"THE STANDARD OF ACCURACY"

GAUGES • DIAL THERMOMETERS • REFRIGERATION INSTRUMENTS • HEATING SPECIALTIES

For more data on advertised products, use Readers' Service Cards, last page.



EFCO does it right

No job is too complicated for Efco's heat-transfer specialists. One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

EFCO'S FOUR POINT PROGRAM PROVIDES:

service-proved engineering design
guaranteed job-ratings
complete fabricating facilities
technical service before, during and after installation

ASK OUR GULF COAST CUSTOMERS — THEY KNOW US WELL

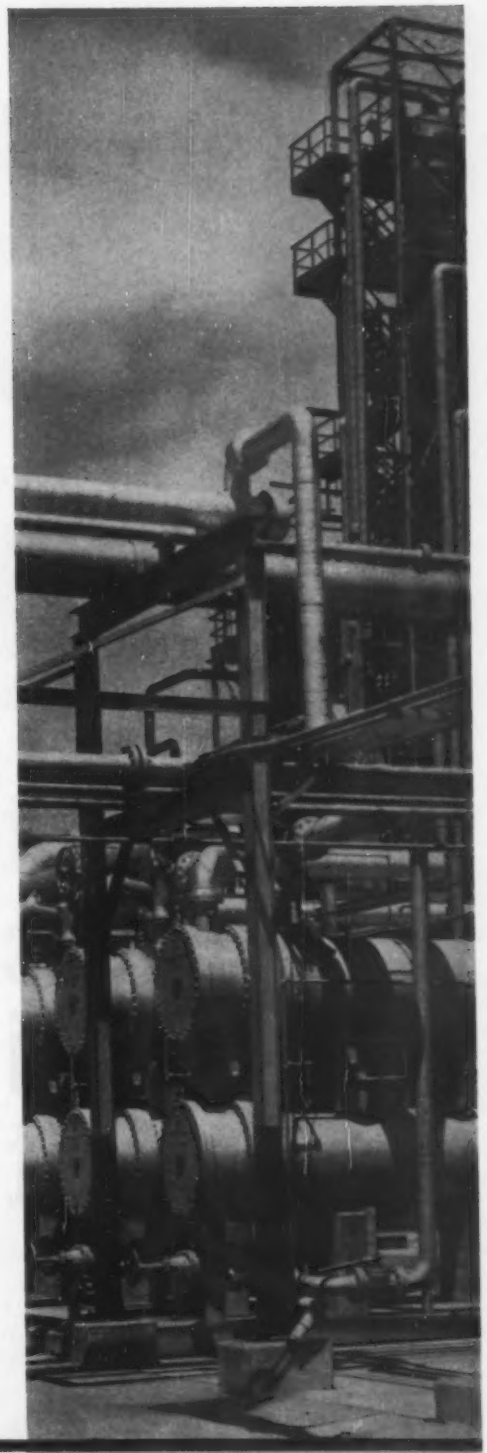
Write for General Catalog

EFCO HEAT TRANSFER EQUIPMENT
Engineers and Fabricators, Inc.
P. O. BOX 7395 HOUSTON 8, TEXAS

EFCO

Oakite ECP
engineered cleaning program

saves tube bundles from scrap heap



Partially plugged with heavy soils after eight years of service, a series of coolers were marked by "Inspection Department" for the refinery scrap pile. Efforts to restore them with circulating acid had been fruitless.

Then, the refinery called in an Oakite engineer. He developed an ECP. For the coolers, it called for circulating a hot solution of Oakite Composition No. 19 under pressure, followed by hot and cold water rinses. In just a few hours, the condensers were completely clean and good for many more years of service.

WHAT IS OAKITE ECP? It's an *Engineered Cleaning Program* that stresses chemical cleaning. It's engineered specifically for your refinery, for your cleaning problems, and for each cleaning operation—tower by tower, valve by valve.

The Oakite engineer lends personal and experienced supervision to each phase of the program. He supplies detailed instruction based on practical knowledge of refinery cleaning needs. Each Oakite ECP is backed by a *laboratory* concentrating on chemical cleaning research, by *materials* known to make short work of refinery soils, by proved *methods*. Send for booklets. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

In our 50th year.

Export Division Cable Address: Oakite

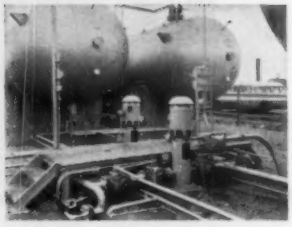
Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP
your economy key

For more data on advertised products, use Readers' Service Cards, last page.

to quench a big thirst–

PEERLESS PUMPS



"Fill it up!" and nearly 60 million automobiles take an annual 56 billion gallon drink. Helping to "set 'em up again" for aircraft, automobiles, L-P gas and diesel engines, virtually every type transportation, is the Peerless Hydro-Line® vertical pump. Available in two basic types, process and transfer, the Peerless Hydro-Line is serving in the handling of hydrocarbons such as gasoline, butane, propane, hot oils, etc.; hot or cold water; mild acids, basic and salt solutions. This flexibility of application, plus its space-saving vertical design, its outstanding NPSH (net positive suction head) characteristics and its ready adaptability to future system requirements, has made the Peerless Hydro-Line truly one of America's most versatile pumps. For complete information on the Peerless Hydro-Line vertical pump line, write for Bulletin No. B-1700.

Putting Ideas to Work

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION ®

FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA
Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.

For more data on advertised products, use Readers' Service Cards, last page.

HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 4 OF A SERIES)

Filters

Basic filter parts include: the outside container, the bed of filter medium and the distribution and collection systems to provide a uniform flow through all parts of the bed. Flow rates average 2 to 3 gallons per minute per sq. ft. of bed area.

Filter beds are cleaned periodically by reversing the flow and increasing it to about 10 to 20 gpm per sq. ft. (backwashing). This lifts and swirls the sand, loosening the dirt and flushing it to waste.

Rotary surface washers with high-velocity water jets may be used to help break up the layer of dirt on top of the bed.

After backwashing, the first water through the filter (rinse water) also picks up some dirt and is run to waste.

A "multiport valve" replaces 5 individual valves and reduces the number of valve manipulations for cleaning a filter from 10 to 3. It also indicates the cycle in progress and ensures proper sequence. Operation can be made completely automatic with hydraulically- or motor-operated valves controlled by meters, timers and float switches.

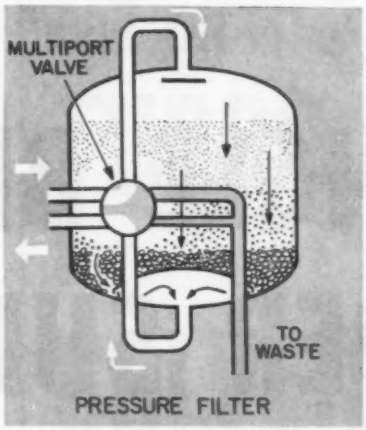
SAND FILTERS for removing dirt, precipitates, suspended solids

Sand filters simply "strain" the water as it flows downward through the filter bed. It is probably the oldest and most widely used method of water treatment.

Gravity filters. Practically all large public water-supply plants include a series of gravity filters made of concrete for permanence and low maintenance cost. Sizes run up to 400 or 500 sq. ft. for each filter.

Chief difference among concrete gravity filters is the method of water collection under the filter bed. The false bottom system provides uniform collection but requires about 2 ft. extra filter height and is highest in cost. Header-lateral collection systems of steel pipe are lowest in cost but do not provide perfectly uniform collection and can corrode. There are also patented systems such as Permutit's *Monocrete*® system which uses collapsible forms for casting lateral ducts in the concrete itself. *Monocrete* ducts are oversize for uniform collection and are corrosion-free since no metal is used. The cost is less than for false-bottom construction.

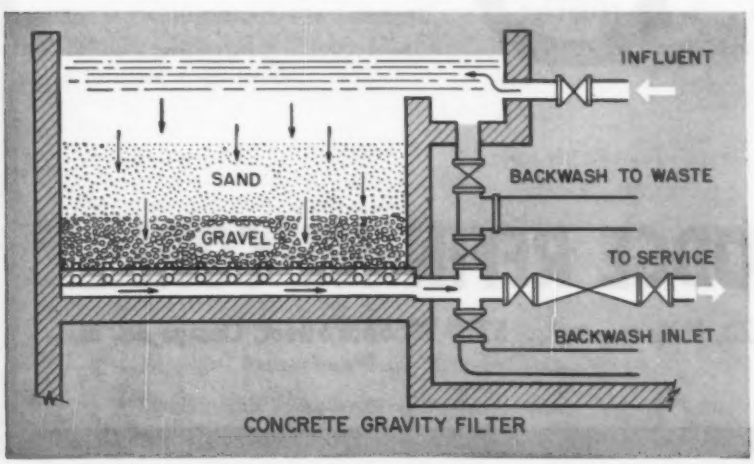
Steel-tank gravity filters cost less than concrete in small and medium sizes and are generally used in industrial plants. Wood-tank filters have low maintenance cost, but they are not practical for large sizes and not as attractive as painted metal. They are now used primarily where there is a metal shortage.



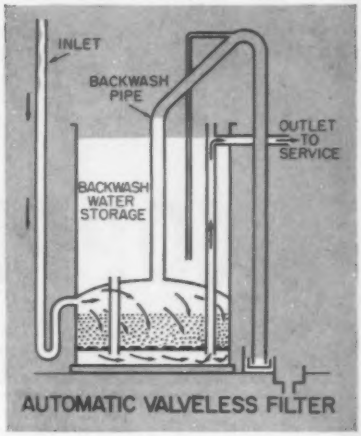
PRESSURE FILTER

Pressure filters deliver an effluent under pressure, usually under 100 psi, to eliminate repumping. Since no water depth is required over the bed to provide pressure, these filters are smaller and lower in cost than gravity filters of the same capacity.

Vertical pressure filters are available to 12 ft. diam. with approx. 113 sq. ft. of bed area. Horizontal pressure filters provide large filter-bed areas, up to 200 sq. ft., at lowest tank cost but may not maintain as uniform bed conditions as vertical type.



CONCRETE GRAVITY FILTER



AUTOMATIC VALVELESS FILTER

Automatic Valveless Filters (gravity type) are a new Permutit development. They greatly reduce filter cost because they use no valves or flow controllers. They provide completely automatic, foolproof self-operation yet actually cost less than conventional manually-operated gravity filters. Sizes up to 12' diam. available.

When the suspended matter removed by the filter bed causes the pressure loss to reach a predetermined figure, backwashing starts automatically. At end of backwash, flow reverses automatically, and the backwash storage compartment is then filled with a brief rinse plus filtered water. Filtered water then passes to service through a separate outlet.

FILTER MEDIA for removing oil, bad tastes, odors, etc.

Graded anthracite coal. Used in place of sand to minimize pick-up of silica following hot-process softening of boiler feedwater or for removal of oil from steam condensate.

Activated Carbon (Carbo-Dur®). Absorbs excess chlorine and dissolved elements caused by decayed vegetation or algae that affect taste and odor. Carbon filters or "purifiers" are backwashed to remove suspended matter picked up by the filter.

Calcium Carbonate (Neutralite) raises the pH of low-pH, corrosive water at the same time that it filters.

Manganese zeolite oxidizes and removes moderate amounts of iron and manganese, also hydrogen sulphide, chief cause of "rotten egg" odor and sulphur taste. It is regenerated with potassium permanganate.

For information on filters or other water-conditioning equipment, write: The Permutit Company, Dept. PR-9, 330 West 42nd Street, New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®
rhymes with "compute it"
a division of PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment

For more data on advertised products, use Readers' Service Cards, last page.

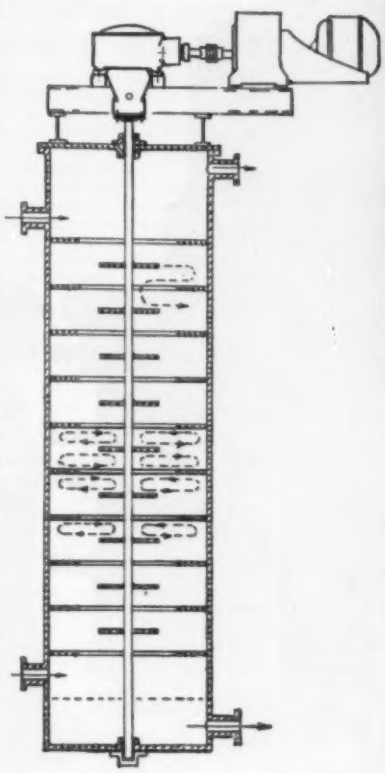
FOR YOUR

COPPER SWEETENING PROCESS

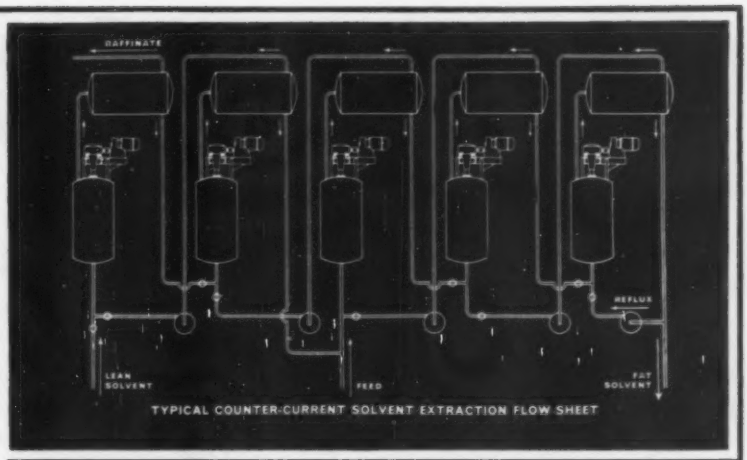
TRIANGLE BRAND COPPER SULFATE

PHELPS DODGE REFINING CORP.

300 Park Ave., New York 22, N.Y. • 5310 W. 66th Street, Chicago 38, Ill.



TURBO-MIXER R.D.C. COLUMN
Licensed Under
Shell Development Company Patent



TYPICAL COUNTER-CURRENT SOLVENT EXTRACTION FLOW SHEET

call on TURBO-MIXER for SOLVENT EXTRACTION

Whether you are extracting uranium with mixer settlers (like Kerr-McGee and Vitro) or butadiene (like Esso Standard or Polymer Corporation) or a continuous counter-current extraction column (like Bakelite), there's a Turbo-Mixer designed exactly to meet your needs.

Turbo-Mixers are designed for maximum service, based on over 40 years of experience and specialization in mixer construction. For descriptive information showing how your problems may be solved by Turbo-Mixer, write today.

FOR DETAILED INFORMATION AND USEFUL DESIGN DATA, SEND FOR THE FOLLOWING BULLETINS:

Please send me the following Turbo-Mixer Bulletin (s):

General Turbo-Mixer Bulletin_____

RDC Extraction Column Bulletin_____

Side Entering Propeller Mixer Bulletin_____

Absorption & Oxidation Bulletins_____

TURBO-MIXER DIVISION
GENERAL AMERICAN
TRANSPORTATION
CORPORATION

TURBO-MIXER GENERAL AMERICAN

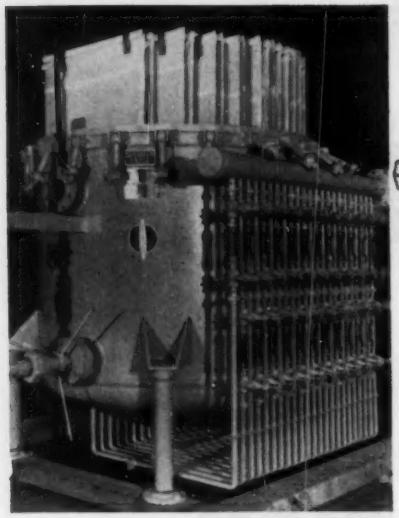
Sales offices: 380 Madison Avenue, New York 17, New York • General Offices: 135 South LaSalle Street, Chicago 90, Illinois • Offices in all principal cities

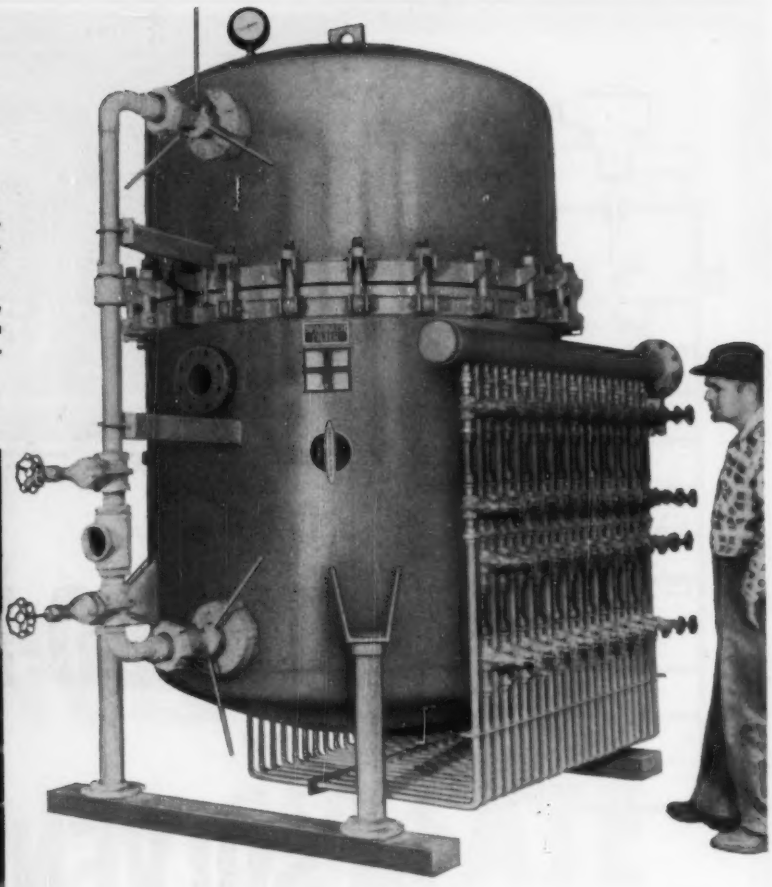
For more data on advertised products, use Readers' Service Cards, last page.

SPARKLER MODEL VF FILTER

All Monel metal filter elements designed for filtering caustic solution. 850 sq. ft. of filtering surface.

Custom engineered for performance in areas with restricted headroom and other plant space limitations.





Another SPARKLER VERTICAL PLATE FILTER

Designed for service in one of America's largest chemical plants

Individual plate outlet control valves, sight glasses and sample cocks. Any plate may be cut out of service without interrupting filtering cycle.

This filter is particularly suited for toxic and volatile products. Sealed tank is maintained throughout cleaning and filtering cycles. Available in capacities from 100 sq. ft. to 1000 sq. ft.

Exclusive new vertical plate design. Rigid and non-collapsible plates, with unrestricted high flow center construction.

Spent cake is easily removed without opening filter with the exclusive Sparkler spray sluicing system.

You can depend on Sparkler for the latest developments in modern filtration engineering.

SPARKLER FILTERS

SPARKLER MANUFACTURING CO.
MUNDELEIN, ILLINOIS U. S. A.

Sparkler International Ltd., Manufacturing Plants at Leliegracht 9, Amsterdam, Holland; Toronto, Ontario, Canada; Italy and Australia.

FILTRATION ENGINEERING AND MANUFACTURING EXCLUSIVELY FOR OVER 30 YEARS.

Why external recalibration is important to users of industrial thermometers

Sometimes it is necessary to recalibrate thermometers in industrial installations due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

To recalibrate the ordinary bimetal thermometer, you must remove the dial glass and move the pointer by hand. You will achieve the desired recalibration of course, but a number of undesirable things may also result. First of all, the instrument's air-tight seal is automatically destroyed in the removal of the dial glass. Secondly, in forcing the pointer, the pointer shaft may become bent or twisted.

Should the pointer shaft become bent even slightly, it can cause the pointer to stick due to improper alignment of the bimetallic shaft on its bearing surfaces. The obvious result, of course, will be inaccurate readings and necessary repair or replacement of the instrument. *None* of these things can happen with the RMC external recalibration device.

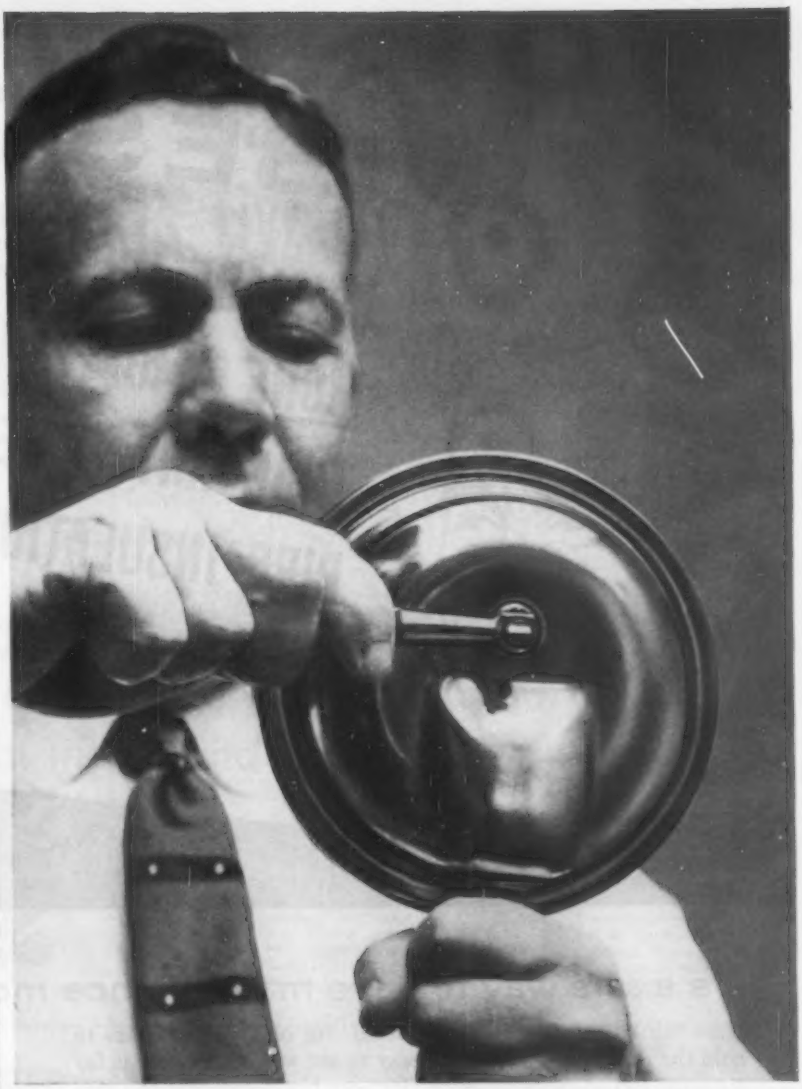
A simple dial-reset screw, located on the back side of RMC industrial thermometers, permits recalibration without opening the instrument in any way. This external recalibration feature is *exclusive* with RMC, along with true dry-air hermetic sealing.

SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

RMC high pressure gauge, developed for missiles, now available to industry

RMC-LINDSAY PRESSUREGAUGES indicate pressures in ranges 0 to 1,000 psi., up to 0 to 15,000 psi., with retard scales available. Multiple coil, helical Bourdon tube type, with pointer attached direct—no linkages or pivots. Can withstand extreme shock, vibration, temperature, or overpressure and maintain consistent accuracy.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 38 Rockwood St., Rochester 10, N. Y.



This maintenance engineer is recalibrating an RMC bimetal dial thermometer by means of the exclusive RMC *external* dial reset screw—a simple on-the-job operation with RMC thermometers.

RMC external recalibration device saves thermometer's hermetic seal

With this *external* dial reset screw you can recalibrate your RMC thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed and there is no chance for damage to the critical pointer shaft. You get the *only* bimetal industrial thermometer that provides for *external* recalibration when you specify RMC.

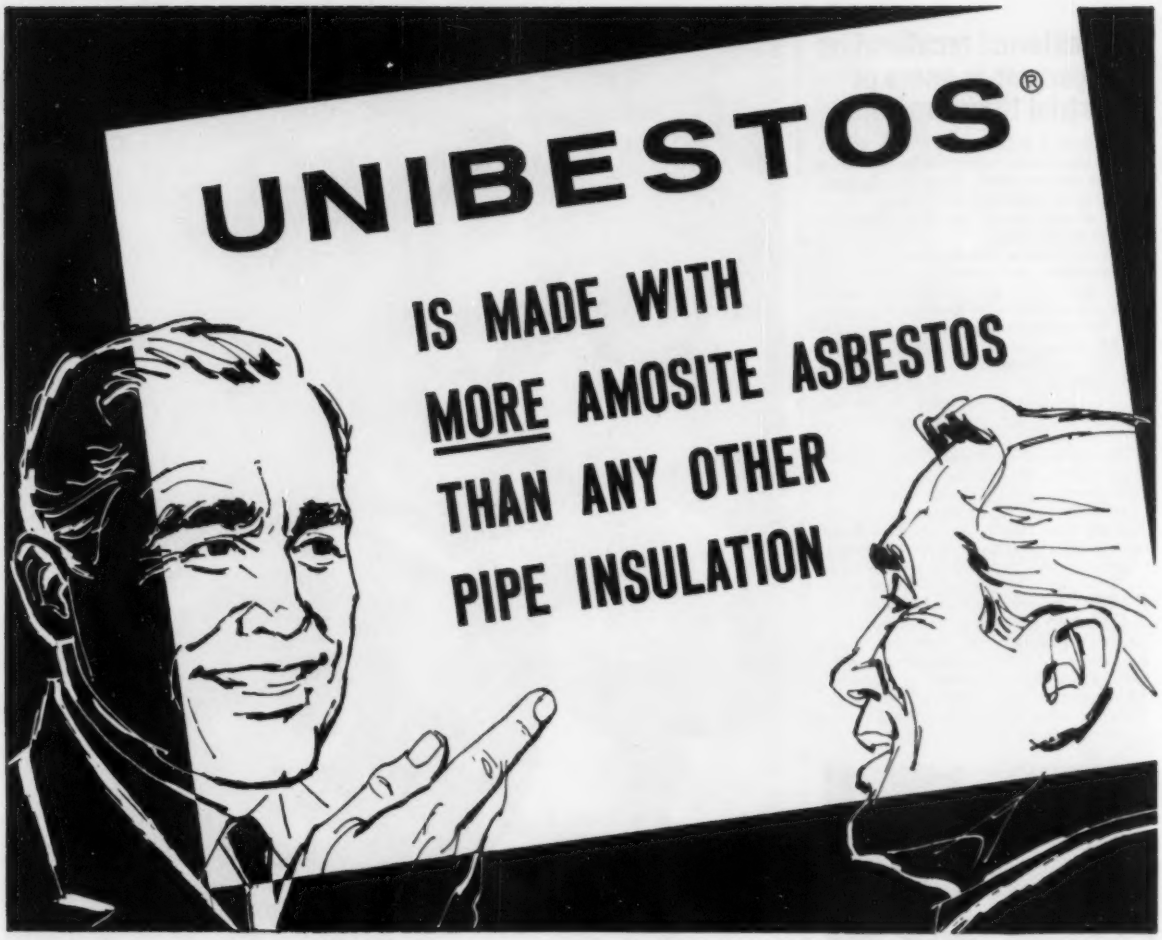
RMC

ROCHESTER MANUFACTURING CO., INC.
38 ROCKWOOD STREET • ROCHESTER 10, N.Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES

For more data on advertised products, use Readers' Service Cards, last page.



It's a *sure* way to save maintenance money!

Most insulations use merely a scattering of asbestos fibers to hold the mass together. So it's easy to see why UNIBESTOS is far stronger and so much *tougher*. Hammer blows can dent the surface, but never shatter nor crack it. You can cut UNIBESTOS cleanly without breakage—walk on it. And, best of all, UNIBESTOS can be removed and replaced repeatedly without damage or loss of efficiency.*

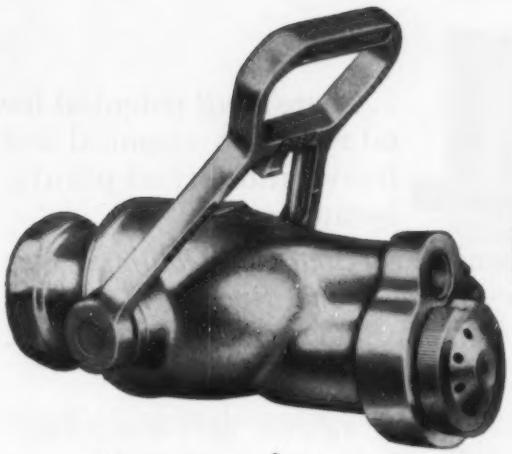
At competitive prices, rugged UNIBESTOS brings you the added advantages of easy installation, single-layer application, simplified fabrication for curves and fittings, unmatched resistance to water and weather. It's the favorite wherever used – the *standard* in plant after plant. We'll be glad to send you complete information on *re-usable* UNIBESTOS...the only pipe insulation made almost entirely of Amosite asbestos. Sizes to 44" o.d.

*At a southern refinery, UNIBESTOS on a 24" hot line in the cracking section has been removed for pipe inspection and cleaning every two months for more than four years. It has paid for itself many times over in maintenance savings alone.

UNARCO®

UNION ASBESTOS & RUBBER COMPANY
1111 W. Perry Street, Bloomington, Illinois

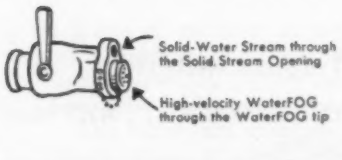
INSULATIONS • PACKING • GASKETING • ASBESTOS TEXTILES • INSULATING CEMENTS

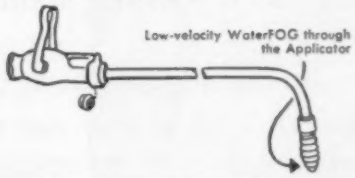


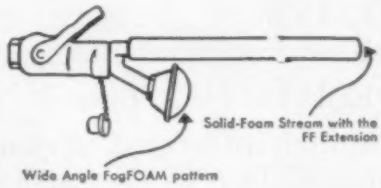
Rockwood SG-60 WaterFOG Nozzle is five nozzles in one

The lightweight Rockwood SG-60 WaterFOG Nozzle *eliminates "special" or single-purpose nozzles!* It actually does the work of five nozzles to put out fires faster, safer and more economically.

Here's what we mean . . .







Here's what you need to put out ordinary combustibles and flammable liquids . . .

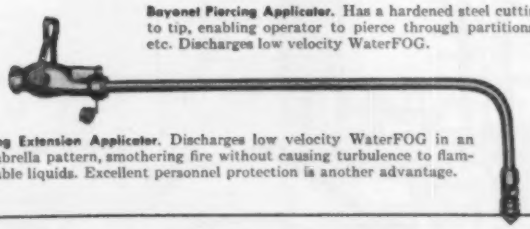
FOAM and "Wet" Eductor with the new FW Metering-Check Valve. Introduces Rockwood FOAM or "Wet" into hose lines, automatically proportioning correct amount of FOAM and "Wet" to water. Also usable wherever one liquid is fed into another on a fixed percentage basis.

Rockwood Double Strength FOAM. Puts out fires in flammable liquids, and in ordinary combustibles, quicker, at lower cost. Three parts FOAM and 97 parts water create a heat-resistant blanket.

Rockwood WET. One part WET mixed with 99 parts water increases water's penetration and extinguishing action. Gives quickest results against deep seated fires. Saves time, water, manpower.

FF Extension Unit. Shown with Type SG-60 Nozzle. Discharges Rockwood FOAM in a solid stream or as Fog-FOAM. Wide angle makes it possible to cover large areas at one time.

Bayonet Piercing Applicator. Has a hardened steel cutting tool attached to tip, enabling operator to pierce through partitions, into interiors, etc. Discharges low velocity WaterFOG.



Long Extension Applicator. Discharges low velocity WaterFOG in an umbrella pattern, smothering fire without causing turbulence to flammable liquids. Excellent personnel protection is another advantage.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Distributors in all principal industrial areas

and here's the way to get more information

ROCKWOOD SPRINKLER COMPANY

Portable Fire Protection Division
1303 Harlow Street
Worcester 5, Massachusetts

Please send me your illustrated booklet on Rockwood fire-fighting products.

Name .....

Title .....

Company .....

Street .....

City .....

Zone ..... *State* .....

For more data on advertised products, use Readers' Service Cards, last page.

POTENTIAL

. . . here's *full* potential for oil refineries, chemical and heavy industrial plants, because . . .

FABRICATION . . . of all types of equipment *(Fractionating Columns, Gas Columns, Pressure Vessels, Plate and Heavy Steel Work, Special Machines, Autoclaves, Shells, Base Bridge Girders)* . . . is performed to order . . . to specification.

MACHINING . . . fully equipped, flexible facilities for machining to close tolerances, regardless of product size or design.

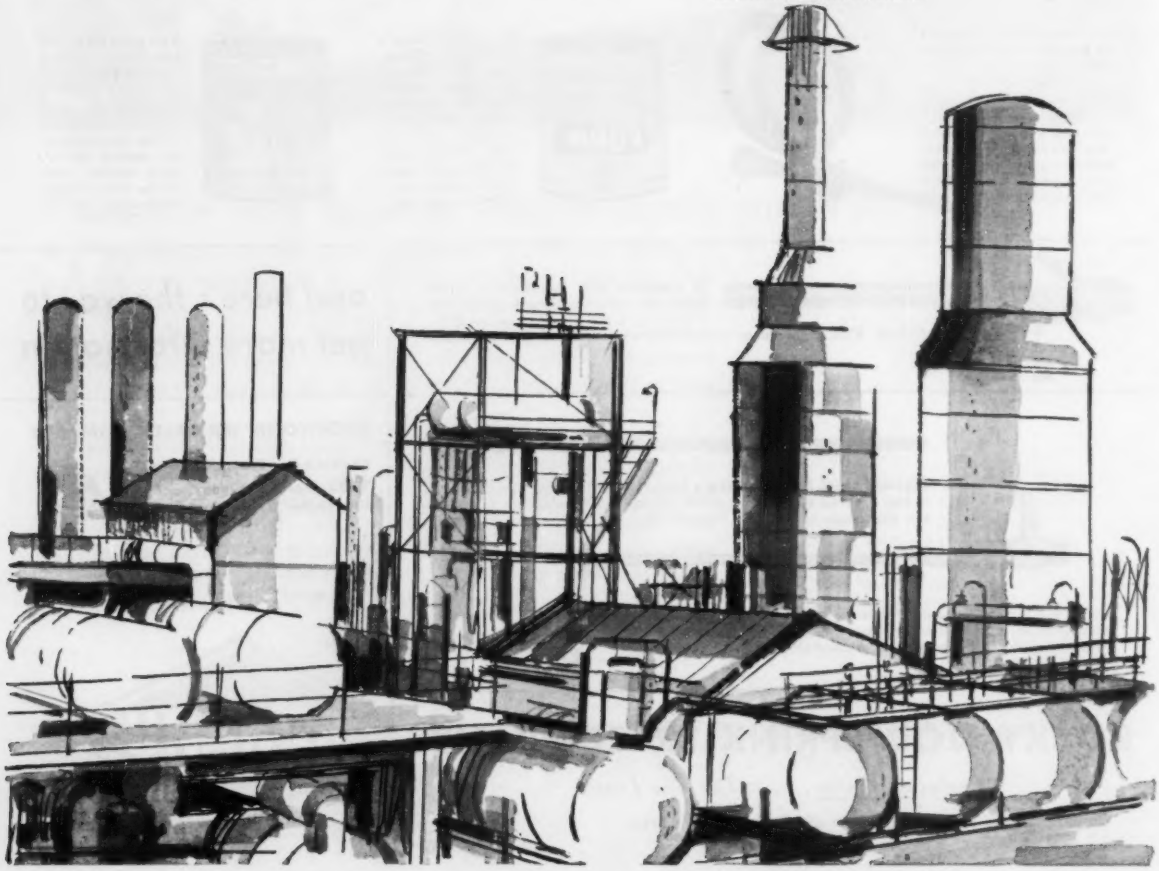
STAINLESS . . . separate, integrated shop for stainless fabrication protects against contamination by ordinary steel.

DELIVERY . . . by rail, truck or inland, coastal or overseas waterway.

Through integrated, efficient operation, Sun Ship can reduce costs . . . increase your POTENTIAL. Call for an estimator or representative.

SUN SHIP

BUILDING & DRYDOCK CO.
CHESTER, PENNSYLVANIA



SOLID WHEEL

spells non-stop turbine performance

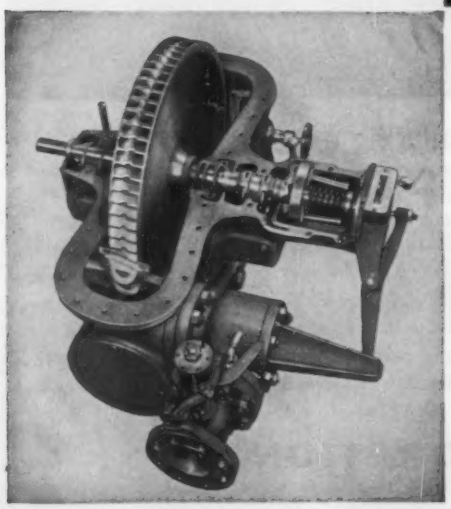
It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.
Terry Square, Hartford 1, Conn.

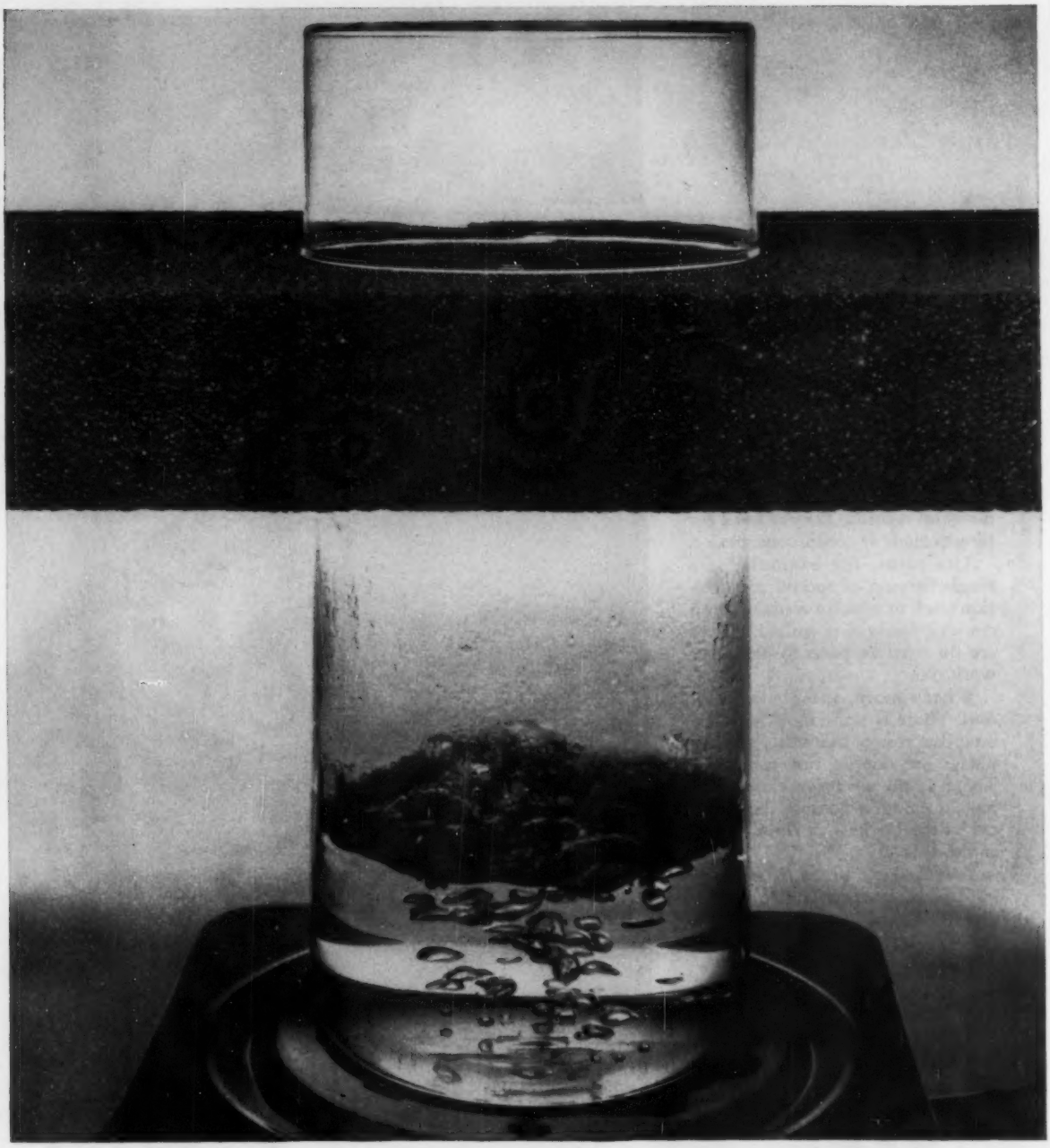


Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY

For more data on advertised products, use Readers' Service Cards, last page.



. . . always an insulation investment; never an insulating expense

FOAMGLAS® IS VAPOR-PROOF

Water vapor is the biggest threat to any insulation's thermal performance. It is present in nearly every situation requiring thermal insulation. Most insulations absorb vapor. When they do, the vapor can condense within the material . . . and turn the insulation into a conductor of heat. Eliminate this threat. Use Pittsburgh Corning FOAMGLAS. Its sealed glass cells can never absorb or transmit vapor (see above) . . . thus guaranteeing long lasting insulating value that never fades from its original high level. There's still more to this insulation investment story. FOAMGLAS is dimensionally stable . . . can't burn . . . unusually strong . . . acid-proof . . . vermin-proof . . . easy, economical to handle and install. Write for our latest literature. PC Glass Blocks are another outstanding building product of Pittsburgh Corning Corporation.

PITTSBURGH CORNING CORPORATION

Dept. Z-98, One Gateway Center, Pittsburgh 22, Pa. • In Canada: 57 Bloor Street West, Toronto, Ontario

Need COOLER RUNNING MOTORS for your big jobs?

In Ratings thru 500 hp Standard TEFC or Explosion-Proof

WAGNER Tube Ventilated Motors can solve your problem

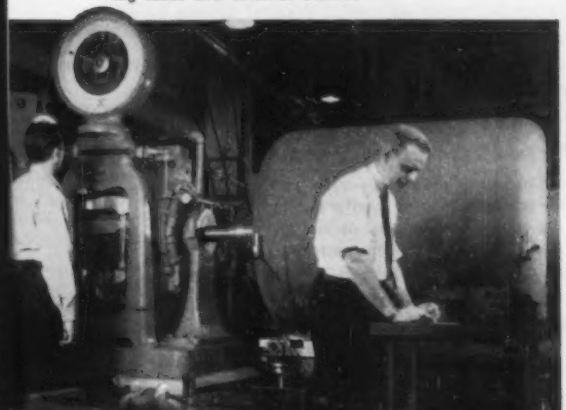
For big fans, blowers, pump drives—heavy duty applications where you need large motors with highly effective cooling systems for long life—choose Wagner Tube Ventilated Motors.

These motors have fabricated steel frames that are provided with a series of tubes through which cooling air is forced by an external blower. Internal blowers, one at each end of the rotor, circulate the warm air inside the motor through ducts in the rotor and stator and around the cooling tubes. This effective cooling system holds the operating temperature of the motor within the specified limits of 55° C Rise for Class A or 75° C for Class B insulated motors.

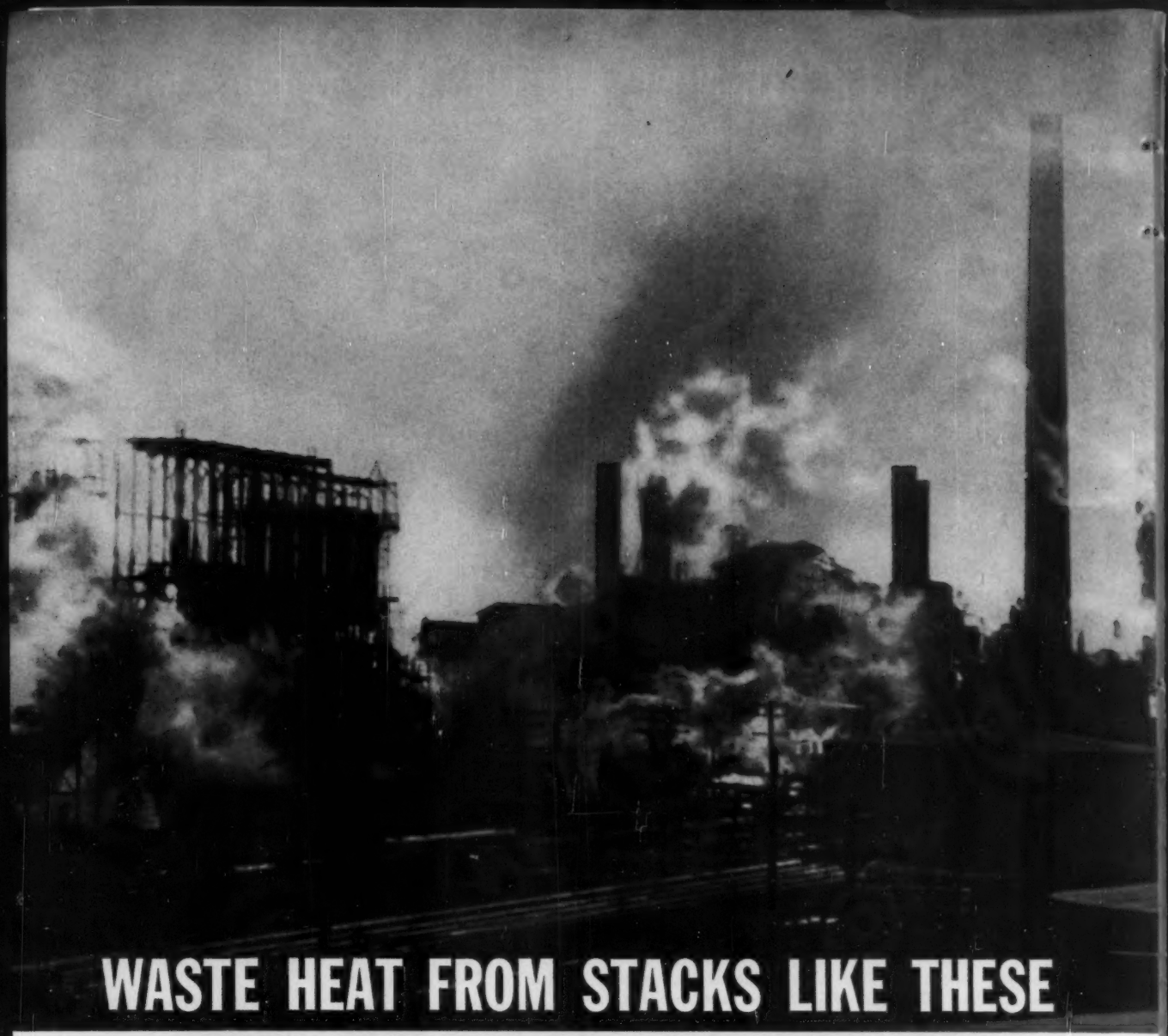
Wagner tube ventilated motors are available as Type YP, standard TEFC, with Class A or Class B insulation; or as Type ZP, explosion-proof, with Class A insulation only. Type ZP motors can be supplied with Underwriters' Labels for Class I, Group C or D, or for Class II, Group E, F or G locations. Let your Wagner Sales Engineer show you how these motors can solve your big motor problems.

WAGNER ELECTRIC CORPORATION • 6458 Plymouth Ave., St. Louis 14, Mo.

This 400 hp tube ventilated motor is being tested on a 1000 hp dynamometer at the Wagner plant. Photo of motor at right, with blower shield removed, shows cooling tubes and external blower.



WM58-12



WASTE HEAT FROM STACKS LIKE THESE COULD PAY 1/5 OF YOUR FUEL BILL

A Ljungstrom® air preheater can cut 20% off your fuel bill by getting more heat from your fuel. That means you burn less of your regular fuel to get the same operating temperature, or you can switch to cheaper fuels without affecting product quality. Either way, every barrel of output can cost 20% less in fuel.

A Ljungstrom air preheater gets more productive heat from any fuel by boosting the temperature of the combustion air — sometimes as much as 1000F. Fuel burns more completely in preheated combustion air, and leaves less slag and deposit behind, so the fuel-burning equipment stays efficient longer.

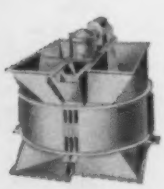
How fast is "WRITE OFF"?

What you save on fuel can pay for the Ljungstrom in two years. If you take advantage of the extra capacity of a Ljungstrom-equipped system to increase output or to improve product quality, the Ljungstrom can pay for itself within nine months.

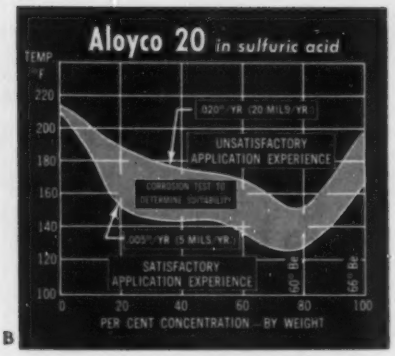
Write today for your copy of a factual article by Mr. O. F. Campbell of Sinclair Refining Company, describing one company's fuel savings with a Ljungstrom air preheater. Call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



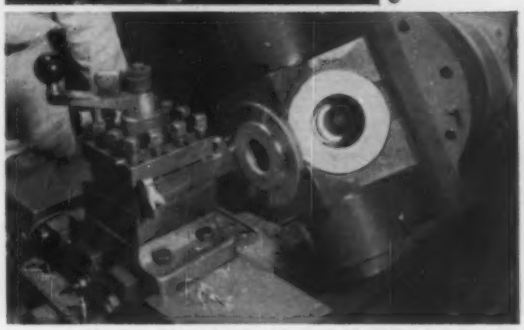
The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.



B

A

C



D

A. Your Problem in handling corrosives is discussed with a specialist when you sit down with an Aloyco Sales Engineer. He handles only one line, knows his business.

B. Right Alloy for your application is based on 29 years of specialized experience in the field plus continuing research in Aloyco metallurgical labs.

C. Valve Casting is made from Aloyco design in Aloyco foundry, only foundry ever built to produce pressure-tight Stainless Steel Valve castings, exclusively.

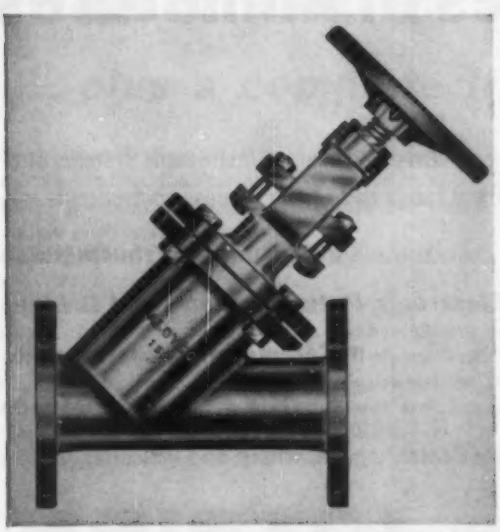
D. Special Techniques in machining stainless steel, plus most modern equipment in Aloyco plant assure you precise tolerances, trouble-free performance.

E. Aloyco Y Valve, shown here in various stages of production, is one of Aloyco's complete line of valve types, alloys, sizes, pressures—including nuclear valves.

BEHIND EVERY ALOYCO VALVE...

specialization

... to help you handle corrosives



E

Valves often look alike—even stainless steel valves. But they won't necessarily perform alike when you get them into the line.

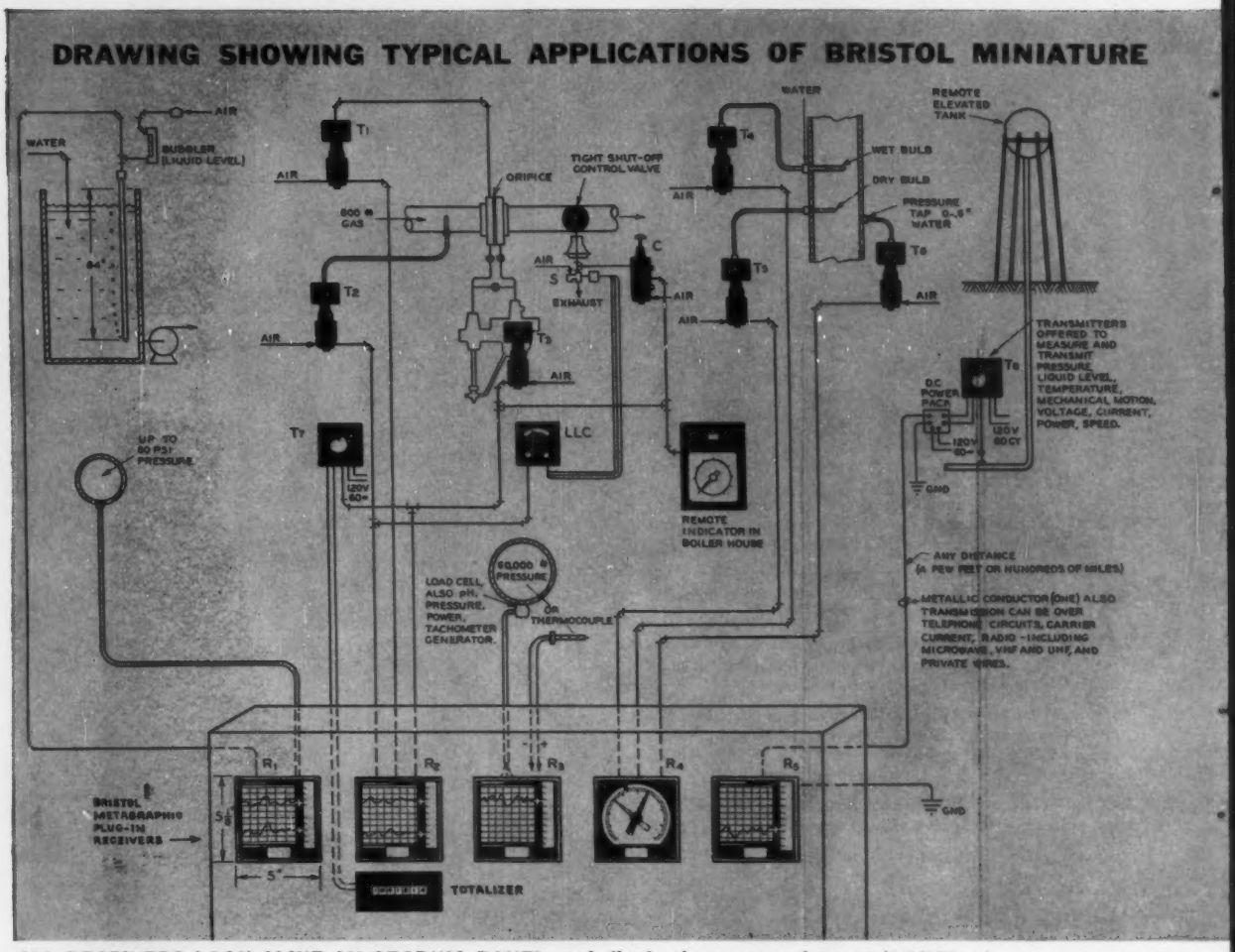
Here are some of the special skills and facilities that make the difference between Aloyco valves and others. Some of the "extras" you get with Aloyco valves are staying power, minimum maintenance, trouble-free operation in severe as well as mild corrosive service. Doesn't it make sense that the one company specializing in the manufacture of Stainless Steel Valves exclusively is your best source of supply?

8.2

ALLOY STEEL PRODUCTS COMPANY

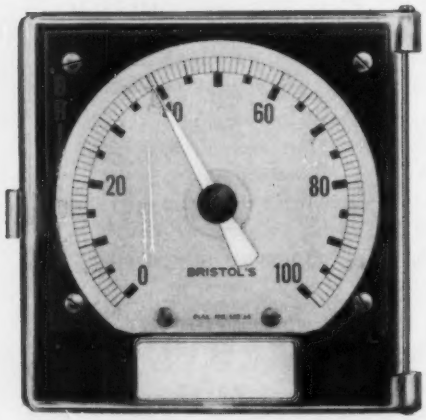
1303 West Elizabeth Avenue, Linden, New Jersey

For more data on advertised products, use Readers' Service Cards, last page.



ALL RECEIVERS LOOK ALIKE ON GRAPHIC PANEL, and all take the same panel cutout (4 9/16" sq.)

Bristol offers: **More types of miniatures**



BRISTOL METAGRAPHIC INDICATORS feature easy-to-read 9-inch effective length scale and interchangeability with recorders of same type.

Bristol Miniature Instrument Systems offer broadest measurement range and widest process control coverage:

- ***Pneumatic Transmission***
- ***Electronic Potentiometers and Bridges***
- ***Telemetering Instruments***
- ***Recording Gauges***

Automatically Controlling, Recording, and Indicating Models

INSTRUMENT SYSTEMS

LEGEND

BRISTOL* METAGRAPHIC TRANSMITTERS

T_1 Pressure
T_2 Temperature
T_3 Differential Pressure or Flow
T_4 Temperature (Wet Bulb)
T_5 Temperature (Dry Bulb)
T_6 Pressure (as low as 0 to 5 mm mercury)
T_7 Integrator
T_8 Liquid Level Metameter Telemeter

*Metagraphic Transmitters are available for temperature, pressure, vacuum, differential pressure, flow, liquid level, mechanical motion, and through the use of the Bristol Dynamaster† Electronic Transmitter any input signal in the form of voltage, current, or change of resistance, capacitance, or inductance such as pH, speed, strain, density, etc.

BRISTOL RECEIVERS

R_1 Pressure or/and Liquid Level Recorder
R_2 Metagraphic Recorder (up to 2 records and 1 indicator)
R_3 Dynamaster Electronic Potentiometer or Bridge
R_4 Metagraphic Indicator—one, two, or three pointers for wide range of measurements or two pointers and one manual remote control.
R_5 Metameter† Telemeter

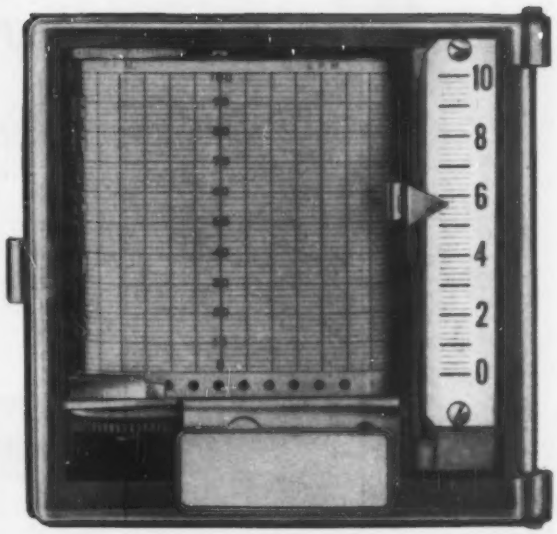
†T. M. Reg. U. S. Pat. Off.

BRISTOL METAGRAPHIC CONTROLLERS

(36 models to choose from—by far widest variety available)

Five Modes of Control

1. On-Off (Fixed High-Gain)
2. Proportional (Adjustable Gain)
3. Proportional-plus-Reset
4. Fixed-Proportional plus Fast-Reset
5. Proportional-plus-Reset-plus Derivative



BRISTOL METAGRAPHIC MINIATURE RECORDERS—whether electronic, pneumatic, telemetering, or gauge types—present a uniform, pleasing easy-to-read panel appearance, measure only 5" x 5 1/8", fit same 4 9/16" square panel cutout.

than any other instrument company

. . . plus a complete line of full-sized instruments

Bristol makes them all. Whatever your choice in instruments, you need look no farther than the complete Bristol line—pneumatic, electronic, miniature telemeters and gauges—all in a *planned* line.

Planned to give graphic panel installations a neat, pleasing, matching appearance.

Planned to give you the widest possible measurement range, the broadest instrument coverage, of any line.

Planned to free you from costly pre-installation decisions as far as practically possible—true plug-in instruments; widest practical number of instrument substitutions; easiest, fastest range changes.

Planned to give you any type of instrumentation—electronic, pneumatic or mixed systems in plug-in miniature construction.

Planned to give you the results of modern human-engineering studies in chart, dial, and indicator visibility and readability.

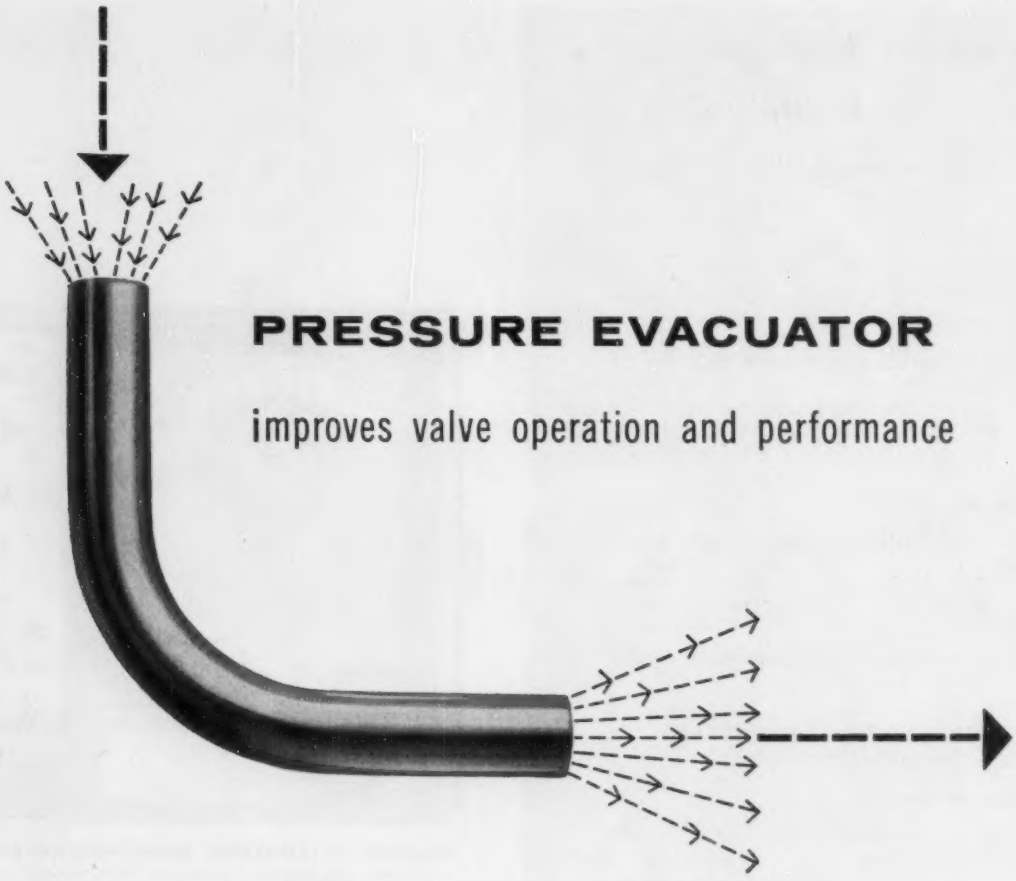
Bristol makes all types, all sizes of instruments, can give you all control modes. That's why Bristol application engineers don't need to shade the facts. When they make an instrument recommendation it's based on our unbiased consideration of *your* problem alone.

Write for complete technical data on Bristol miniature instruments today. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. e.e

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

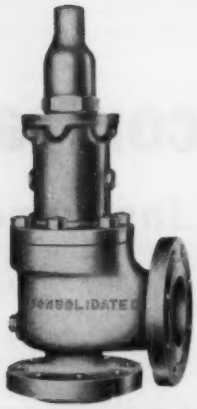
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.



PRESSURE EVACUATOR

improves valve operation and performance



Consolidated Safety Relief Valve, Type 1900 Series, Sizes: 1" x 2" to 8" x 10".

The Eductor Tube in Standard Consolidated Safety Relief Valves is a pressure evacuator. It efficiently removes pressure from the closed bonnet. If allowed to remain in the bonnet, the pressure would act on the top of the disc and tend to limit the lift and induce cycling. But with the pressure evacuated from the closed bonnet through the Eductor Tube, the spring alone controls valve action. Consequently, *reliable* valve action and guaranteed capacity ratings are attained. A new high in operational dependability is assured.

Reliable operation and performance of Consolidated Safety Relief Valves are your assurance of absolute protection for personnel and equipment. "2 in 1" design permits you to convert the Standard valve to the Bellows type in your own shop. But that is only part of the total economy of these modern valves. Get the complete inside story. Write for Catalog 1900.

MAXWELL MANNING & MOORE INC. MM TRADE MARK

T2-58

CONSOLIDATED SAFETY RELIEF VALVES

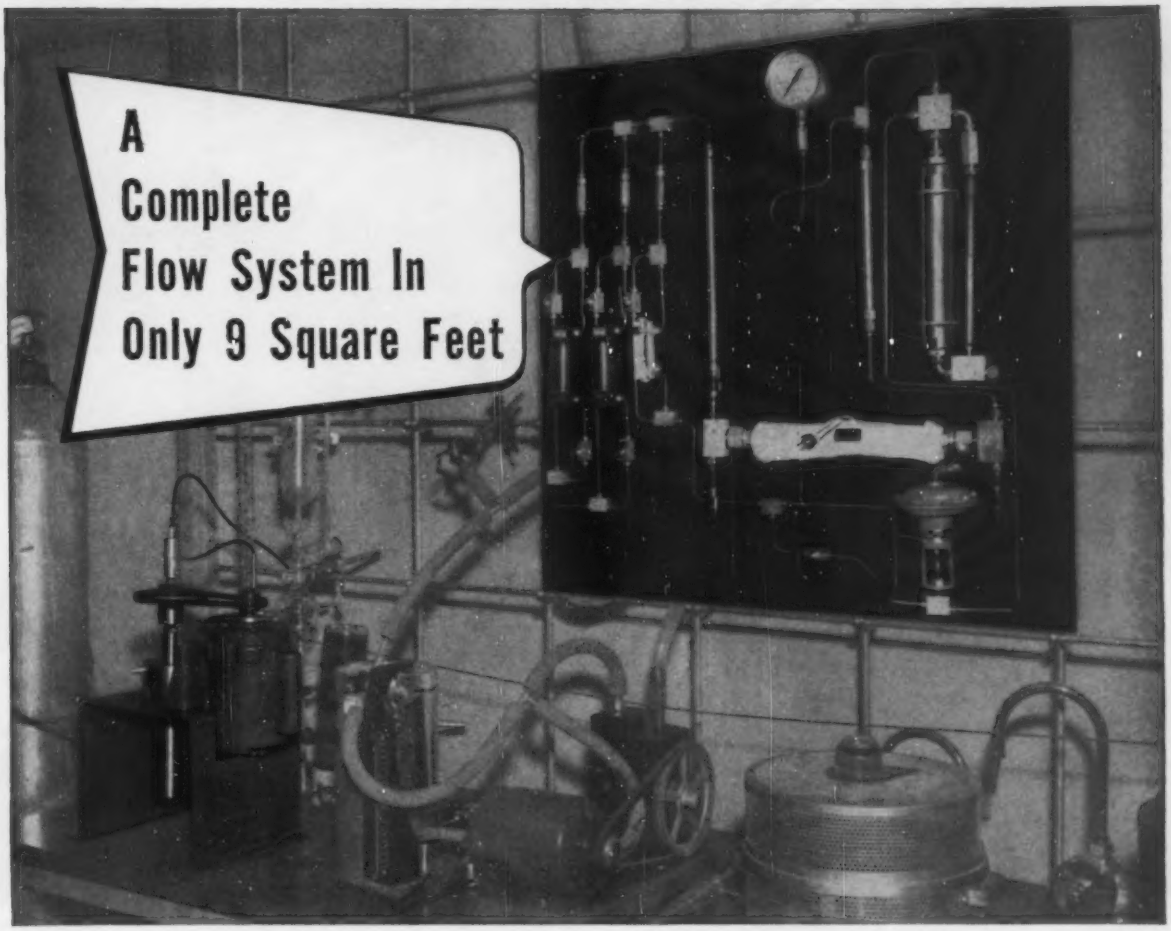
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data on advertised products, use Readers' Service Cards, last page.



For Feasibility or Exploratory Studies In YOUR Lab...
Complete BENCH-SCALE Research Equipment From AE

To save you time, money and trouble, Autoclave Engineers now makes available to you, for the first time, *a complete integrated* line of *professionally designed* bench-scale research equipment for pressures up to 5000 p.s.i. Included are valves, fittings, autoclaves, reactors and auxiliary vessels.

This AE BENCH-SCALE equipment enables you to carry out in your own laboratory a wide variety of preliminary investigations such as feasibility studies before proceeding with scaled-up operations . . . research studies where only minute or limited quantities of expensive materials are available . . . batch, semi-batch or continuous reactions . . . and many other exploratory studies.

Best of all are the savings in space, time and money you'll realize with this equipment. You *save space* because every unit is specifically designed for bench-scale work. You *save time* in setting up or altering the system because of simplicity of design and resultant ease of assembly. And you *save money* because the equipment is easily and quickly assembled by your own laboratory personnel—neither skilled craftsmen nor special tools are required.

Detailed information on AE BENCH-SCALE Research Equipment is given in Bulletin 658. Send for your copy today.

AUTOCLAVE ENGINEERS, INC
2940 WEST 22nd STREET, ERIE, PENNSYLVANIA

For more data on advertised products, use Readers' Service Cards, last page.

Austin-Western Hydraulic Crane lowering section of pipe upon a flat bed truck. Superstructure in background is one of the flashing units at Wood River Refinery, Roxana, Ill.

Austin Western hydraulic crane speeds repairs at

Shell's Wood River Refinery

Shell's Wood River Refinery, Roxana, Ill., had six larger cranes, yet in 1955 purchased an Austin-Western for faster handling of 5-ton loads and less.

The company reports: "This crane with its 16-in. tires, four-wheel power steer and four-wheel drive saves time in pulling exchanger tubes and getting around pump houses. With it the men remove heads of heat exchangers, a job that formerly required a large crane, which was more expensive to operate or called for chain blocks which took more men at increasing labor rates. Maintenance men request this hydraulically controlled and maneuverable light crane to lift and transport pumps into the machine shop for repair. It can set a pump right on a boring mill, for instance, without additional handling."

Moves right up to the work. "Being low slung, the A-W goes under the lines in the pipe alleys where larger equipment could not pass. . . . With its 12-ft. extension added to the 18-ft. extensible boom, this crane can remove pump parts through a window section at second story height and later replace them. When a shaft or impeller requires repair in such a location the A-W saves a great deal of hand rigging and consequently many man-hours of time."

Sometimes works around the clock. "Any one of 10 cranemen may be called on to handle the A-W. In the busy season of the year it is sometimes used 7 days a week, right around the clock. . . . It is likely to handle a dozen jobs in 8 hours. . . . New uses for this versatile crane are being [continually] found."

Low cost operation. "The operating cost of this crane is about what other users report for 8 hours' daily use — less than one man's wages."

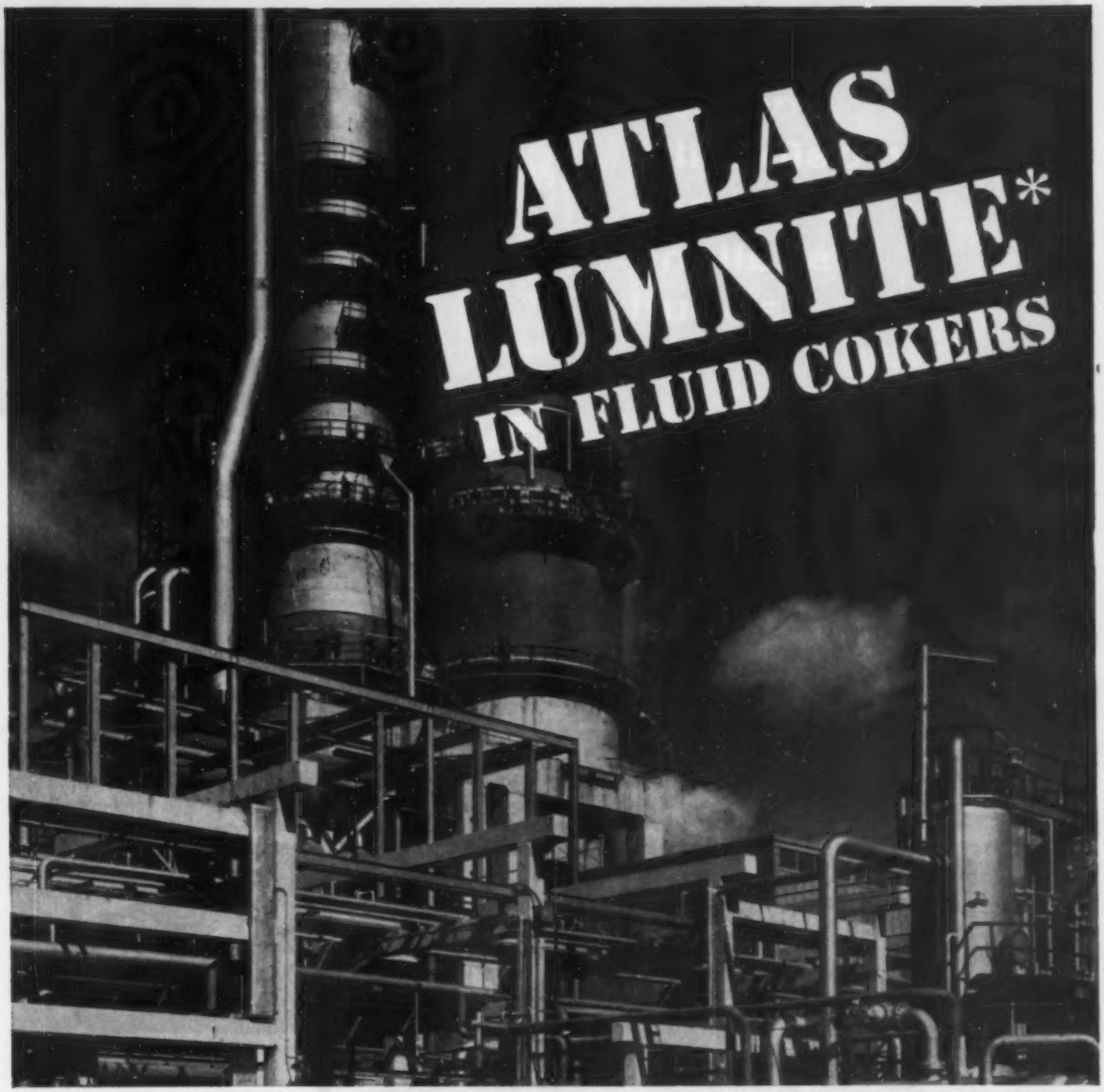
Get the full story at Shell
Write for Certified Gould Report No. 5612

Austin-Western CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

BALDWIN BLH LIMA-HAMILTON



42,000 B/D coking unit whose major vessels are lined with "Resco Cast RS-3" insulating refractory castable made with LUMNITE cement. Tidewater Oil Company, Delaware Refinery. Engineers & Constructors: C F Braun & Co., Alhambra, California. Castable Manufacturer: Refractory Specialties Co., Philadelphia, Pennsylvania.

resists heat . . . combats corrosion . . . insulates

- Industrial concrete linings (made with LUMNITE calcium-aluminate cement and suitable aggregates) help solve heat, corrosion and insulation problems in vital refinery equipment.
- Shutdowns due to installation (or repairs) are minimized because placement is fast and easy — service strength is reached within 24 hours.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For your copy of the "Lumnite Mortar Manual," describing gun-applied linings, write:
Universal Atlas, 100 Park Avenue, New York 17, N. Y.

*ATLAS *and* LUMNITE *are registered trade-marks*

L-167

UNIVERSAL ATLAS CEMENTS

Universal Atlas Cement
Division of United States Steel

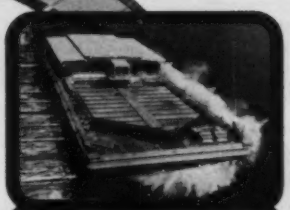
USS

OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

For more data on advertised products, use Readers' Service Cards, last page.

The new corrosion film everyone is talking about!

Here is an authoritative film that answers many questions on the theory of corrosion and demonstrates methods by which it is controlled. Presented in color and sound, it ranges from the formation of anodes and cathodes through the use of galvanizing, inhibitors, metallizing, cathodic protection, alloys and protective coatings. You will see how many corrosion problems in industries such as yours are being solved by Dimetcote, a one-coat zinc silicate protective coating. This film will be well worth 19 minutes of your time. To arrange a showing for you and your associates, or to learn when it will be shown in your area, contact any of the Amercoat offices listed below.



Typical audience reactions:

Bishop, Tex.—"Planning fair-sized test after seeing this film."

Louisville, Ky.—"Answers many questions. Second showing arranged."

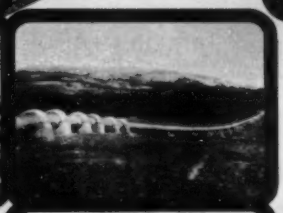
Cincinnati, Ohio—"Key personnel evidenced considerable interest."

Netherlands Antilles—"Both shows led to 45-minute discussions."

Fairport, Ohio—"Very interesting. Will try methods shown."

Las Piedras, Venezuela—"Putting ideas to work in near future."

Bartlesville, Okla.—"Viewed by 42 key men from five divisions."



Answers these and other questions:

What produces electrolytic corrosion?

What factors favor hot-dip galvanizing?

How important is surface preparation?

Can a coating survive a tank fire?

Can rust in tankers be controlled?

Can a coating offer cathodic protection?

What are the corrosion problems on offshore rigs?

What are the advantages of zinc silicate?

How can chemical plants cut painting costs?

Amercoat® CORPORATION

Dept. V1 • 4809 Firestone Boulevard
South Gate, California

• 921 Pitner Avenue • Evanston, Illinois
• 2404 Dennis Street • Jacksonville, Florida
• 360 Carnegie Avenue • Kenilworth, New Jersey
• 6530 Supply Row • Houston, Texas

112A

COLORS

in fluid form

DYE CONCENTRATES*

by **PATENT CHEMICALS**

the Pioneers in Petroleum Dyes

FOR CLEANER, EASIER COLORING OF PETROLEUM PRODUCTS; ELIMINATES PRE-DISSOLVING, DUSTING, OPERATOR EXPOSURE • LESS SKILL AND EQUIPMENT REQUIRED: INTRODUCED DIRECTLY INTO THE FINISHED PRODUCT • THE ANSWER TO BULK, TANK TRUCK, TANK CAR, BARGE, TERMINAL AND PIPELINE COLORING • CAN BE USED WITH DRY DYE EDUCTOR EQUIPMENT • THE USE OF DYE CONCENTRATE INVOLVES NO ADDITIONAL COST COMPARED TO ORDINARY DRY DYES.

FOR USE IN

Gasolines — Diesel Fuels — Fuel Oils — Lubricating Oils
Automatic Transmission Fluids — Break-in Oils and Greases

Also Available in Dry Dye Form.

Dye concentrates can be prepared to customer specifications.

•

Samples and description upon request.

PATENT CHEMICALS, INCORPORATED

MANUFACTURERS OF DYES AND CHEMICALS FOR THE PETROLEUM INDUSTRY

CALL US COLLECT FOR FAST ACTION

•

PHONE MUlberry 4-1726-7

NOTE: — *Reds — Yellow — Orange — Blue — Meet Mil-F-5572 Specifications*

*Patent Pending

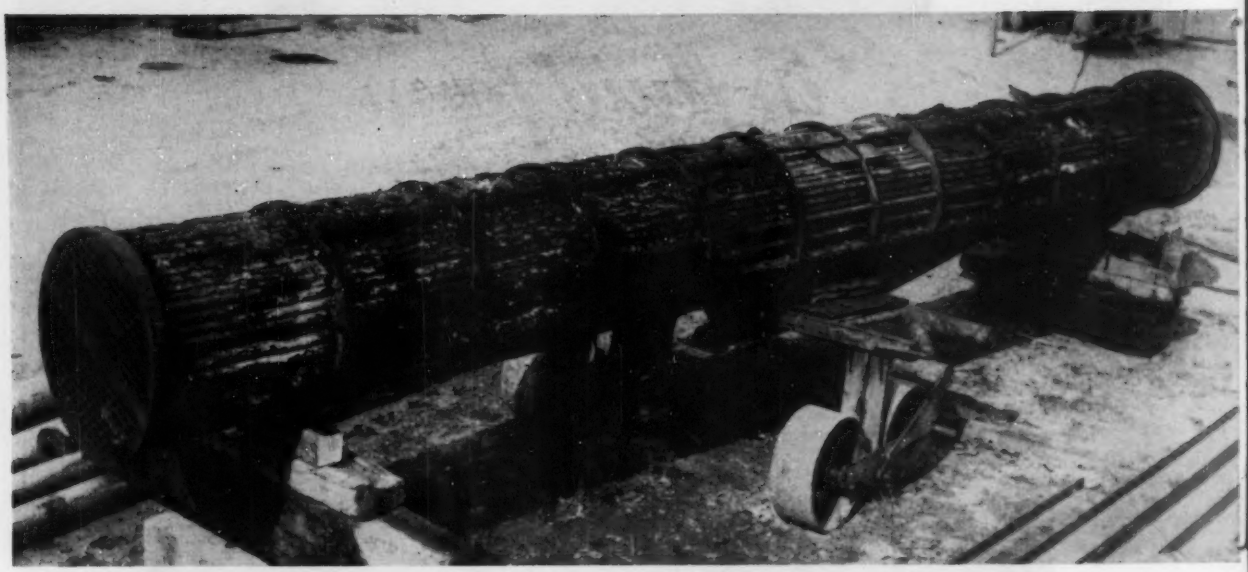
PATENT CHEMICALS INC.

Manufacturing Division: 335 McLean Blvd., Paterson 4, New Jersey

PATENT FUELS & COLOR CORP.

Marketing Division: 2410 Carew Tower, Cincinnati 2, Ohio

CAUSES OF FOULING AND



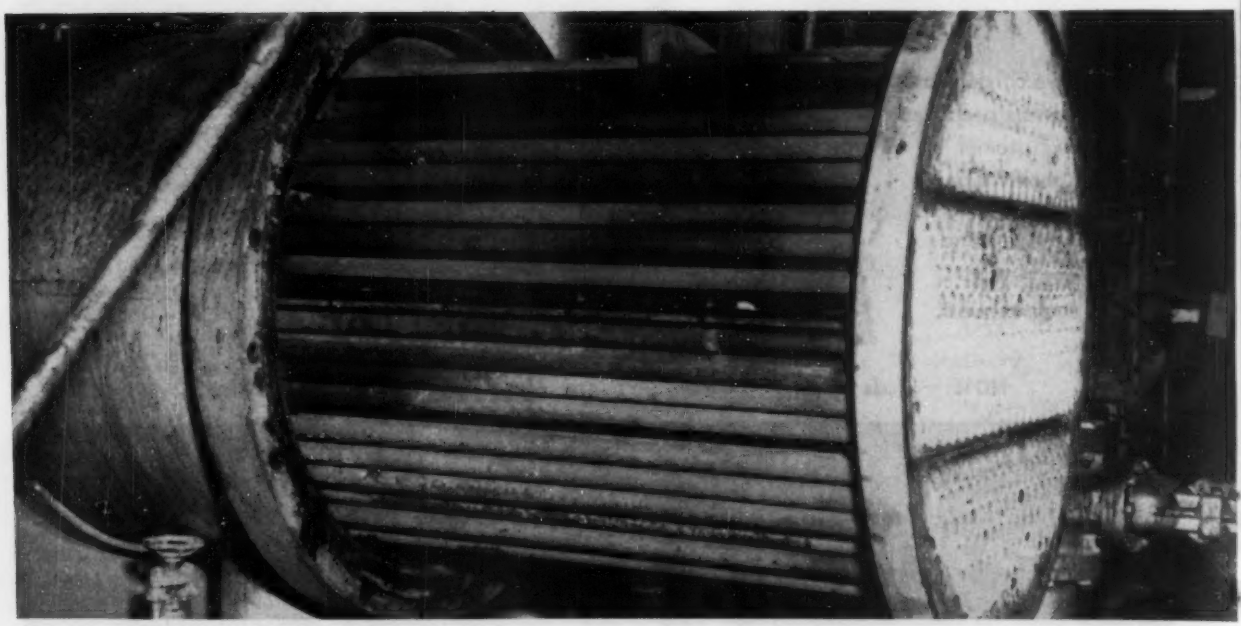
CLEAN . . .
AFTER TWICE THE SERVICE

▲

After 9 months, processing 1 million barrels of naphthenic coastal crude, gasoline cooler bundle is severely fouled and corroded, requiring extensive cleaning and re-tubing.

After 18 months, processing 2 million barrels of same crude—but with CRONOX C treatment used continuously—bundle is clean, needs only hosing before returning to service.

▼



CORROSION ARE ELIMINATED

. . . by simple treatment of crude with CRONOX® C

Refineries can enjoy important savings in the operation and maintenance of crude units by using the CRONOX C conditioning treatment, which actually *removes* corrosive and fouling agents from crude oil.

Longer periods on stream. In typical refineries where CRONOX C treatment is in regular use, time between turnarounds has been doubled, increasing annual throughput by many days. Turnarounds are scheduled less frequently, are shorter and less costly.

Increased equipment life. Within the crude unit, preheat and bottoms exchangers, crude heaters, towers and overhead equipment not only last months, even years longer, but all perform more efficiently because they stay clean.

CRONOX C conditioning solution chemically treats the desalted feed-stock two ways. First, it removes oxygen from the crude, thus retarding corrosion by hydrogen sulfide and preventing the formation of fouling gums, scale and coke. Second, it neutralizes hydrochloric and naphthenic acids, rendering these agents harmless. CRONOX C conditioning solution and the reaction products formed have no effect upon products or catalysts.

Simple to use. CRONOX C treatment is not an extra process, needs no extensive control. Simply inject CRONOX C conditioning solution into the suction of the crude charge pump. The chemical injection system is a simple arrangement of equipment you probably have on hand.

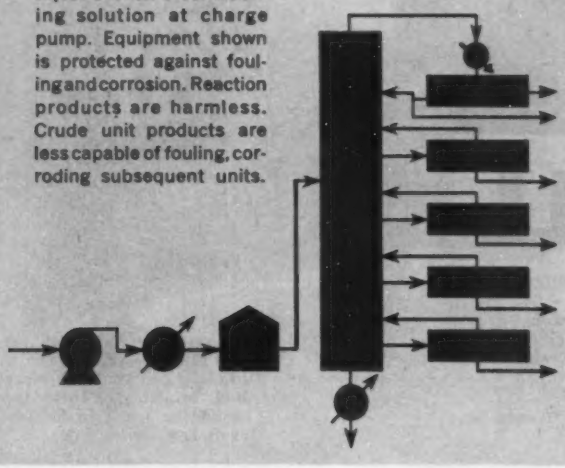
For complete data, send us the coupon below.

ATLAS

Aquaness *Department*

ATLAS POWDER COMPANY

2005 Quitman Street, Houston 26, Texas



Inject Cronox C conditioning solution at charge pump. Equipment shown is protected against fouling and corrosion. Reaction products are harmless. Crude unit products are less capable of fouling, corroding subsequent units.

Aquaness Department, Atlas Powder Co.
2005 Quitman Street, Houston 26, Texas

_____ Please send me a copy of the new Booklet on Cronox C.

_____ Please have a representative call.

NAME _____

COMPANY _____

STREET _____

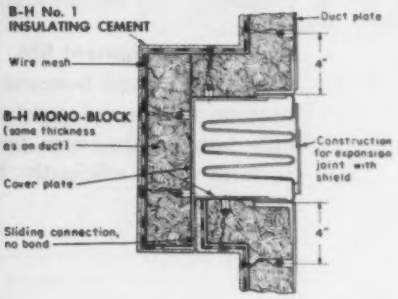
CITY _____ ZONE _____ STATE _____

For more data on advertised products, use Readers' Service Cards, last page.

One Block Insulation that gives you Easier Handling, Faster Application...

BALDWIN-HILL MONO-BLOCK®

Ducts and housings on two 560,000 lb. per hr. boilers, operated by a large Taconite producer in Minnesota, were insulated with B-H Mono-Block (effective to 1700° F) by simple, standardized methods which permitted minimum application cost. The light weight of Mono-Block as well as its ease of cutting holes for tie wires and shaping to conform to surface irregularities facilitated the special insulating treatment of duct flanges and stiffeners. For a finish coat, B-H No. 1 Insulating Cement was used.



Duct Expansion Joint

An interesting application of Mono-Block is on the expansion joints where movement will exceed 3". Block was applied to two independent sections capable of sliding with respect to each other.

BALDWIN-HILL Company

708 Breunig Ave., Trenton 2, N. J.

Kalamazoo, Mich. . . . Huntington, Ind. . . . Temple, Tex.

For more information on B-H Mono-Block, B-H No. 1 Insulating Cement and other B-H Insulations, write for catalog or see it in Sweet's Plant Engineering File.

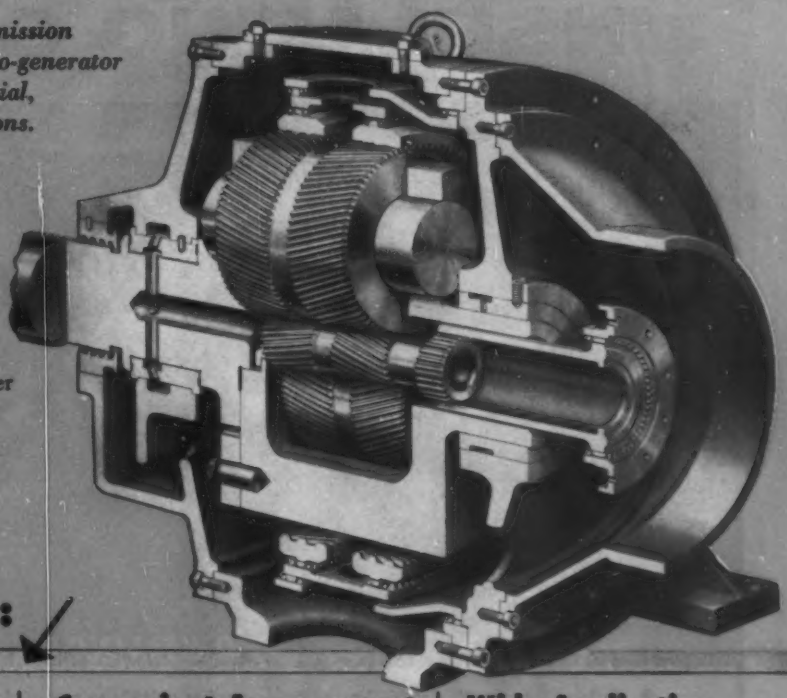
DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

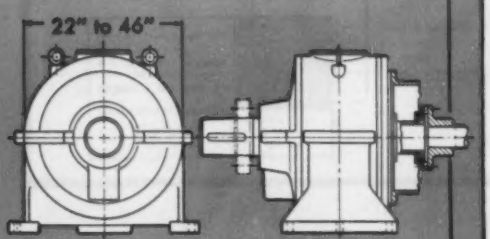
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)...no high speed bearings...less friction losses.



Check These Advantages:

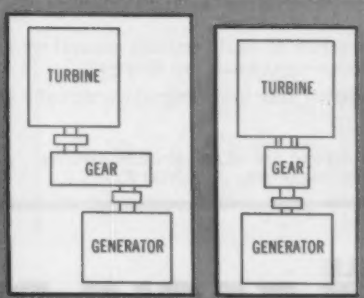
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



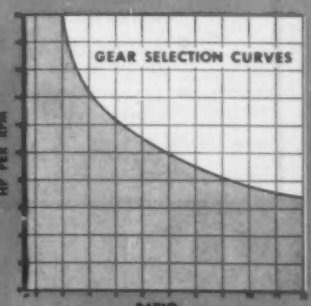
Convenient Arrangement

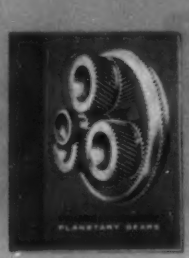
Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.





For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

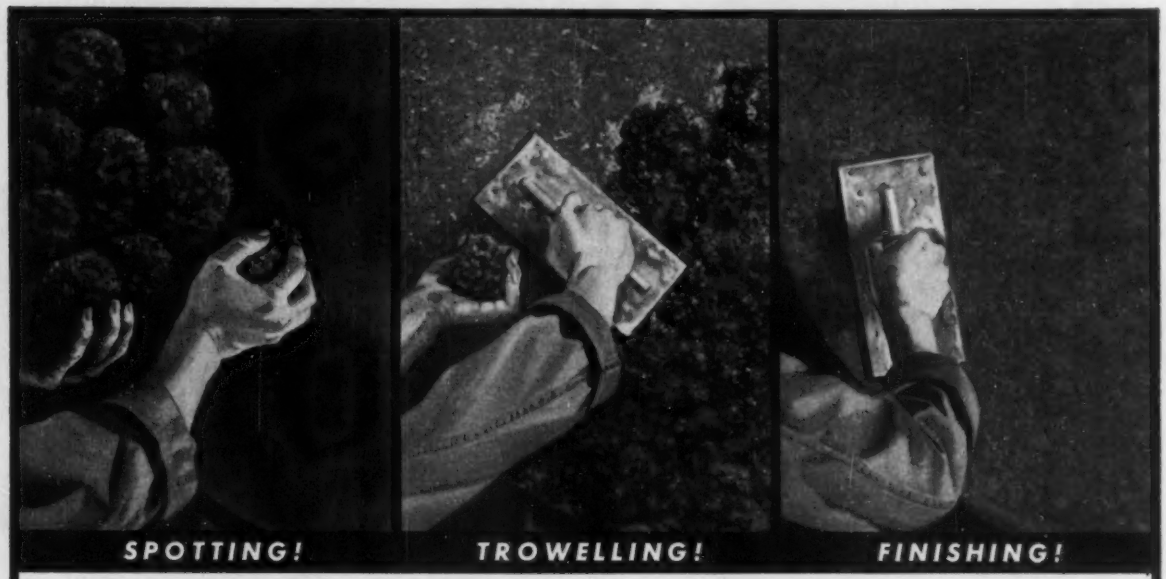
811 Nottingham Way, Trenton 2, New Jersey

IT STICKS TO HOT OR COLD SURFACES!

EAGLE-PICHER

SUPER "66"

INSULATING CEMENT



SPOTTING! TROWELLING! FINISHING!

- Because it sticks, Super "66" saves time—applies quickly to any equipment, cold or hot! Effective up to 1800 F.
- Because it sticks, Super "66" saves money—provides far greater coverage and more efficient insulation.
- Because it sticks, Super "66" makes difficult jobs easy—can be used on irregular shapes where application of other insulations is often impossible. Usually requires no reinforcing on applications up to 1½ inches thick.
- Unique "springy ball" structure of small, resilient mineral wool pellets results in maximum efficiency—maximum fuel savings!
- Super "66" contains a special rust inhibitive which actually prevents corrosion!

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.

FREE SAMPLE!

Write today!

Eagle-Picher Super "66" Insulating Cement conforms to Commercial Standard CS-117-49.

Since 1843

EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices: Cincinnati 1, Ohio

(*Member of Industrial Mineral Fiber Institute*)

HIGH CAPACITY PACKAGED STEAM GENERATORS

by Foster Wheeler

One of two AG-246 units, each capable of generating 50,000 lb/hr sold to C. F. Braun & Co. of Canada Ltd. for installation at the new Cities Service Oil Co. Ltd. at Trafalgar, Ontario

Series AG-200 extends economy and dependability of FW Packaged Design to over 60,000 lb/hr

To meet the needs of industrial plants for high-capacity Packaged Steam Generators, Foster Wheeler offers units for capacities of 50,000 to 63,000 lb/hr and higher, depending on operating conditions.

A modification of the proven AG-100 design which has provided industry with reliable, economical steam in the range of 10,000 to 50,000 lb/hr, these compact, space-saving units permit more steam capacity in less space than has heretofore been possible. For complete details, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FEATURES:

- Final Steam Temperatures to 840 F
- Design Pressures to 900 psig
- Standard Heat Recovery Arrangements Available
- 42-inch Steam Drum
- Two Burners
- Automatic Controls
- Suitable For Indoor or Outdoor Installation
- Tangent Bare Tube Furnace Side Walls and Roof
- Staggered Boiler Bank Tube Arrangement
- Fully Drainable and Removable Superheater.

THE FOLLOWING AG-200 UNITS ARE NOW IN PRODUCTION:

Capacity lb/hr	Operating Pressure psig	Final Steam Temperature Deg. F	Feedwater Temperature Deg. F	Fuel	Efficiency	Steam Quality
52,500	400	750	200	No. 6 Oil	85.5	3 ppm Solids Carryover
60,000	285	Sat.	220	Nat. Gas	78.3	3 ppm Solids Carryover
63,700	150	Sat.	225	No. 6 Oil	83.7	0.5% Moisture Carryover
68,000	620	Sat.	350	No. 6 Oil	80.9	1 ppm Solids Carryover

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data on advertised products, use Readers' Service Cards, last page.

Foxboro introduces

ELECTRONIC CONSOTROL* INSTRUMENTATION

On September 15th, at the I.S.A. Show in Philadelphia, The Foxboro Company will unveil Electronic Consotrol Instrumentation...counterpart of its world-famous pneumatic Consotrol line. ✓ ✓ ✓ Including a complete range of transmitters, indicators, recorders, controllers and valve operators, Electronic Consotrol Instrumentation covers every function in the control loop...provides advanced-design electronic control systems for all modern requirements. ✓ ✓ ✓ In these systems, process measurements such as temperature, pressure, flow and level, are converted to a proportional current signal at the transmitter. Long-distance transmission is instantaneous...over unshielded lines...to small-case, Consotrol panel-type receivers at the central control station. ✓ ✓ ✓ The full story on this major Foxboro contribution to better process control will be presented in Booth No. 12-72 at the I.S.A. Show. Or, write for comprehensive Bulletin 21-10. The Foxboro Company, 749 Neponset Avenue, Foxboro, Mass.

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

Foxboro makes a better instrument...
or Foxboro doesn't make it

Fabricators of:

PRODUCTS

Absorbers

Bubble Towers

Bubble Caps

Bubble Trays

Dephlegmators

Evaporators

Fractionating Columns

Jacket Water Coolers

Heat Exchangers

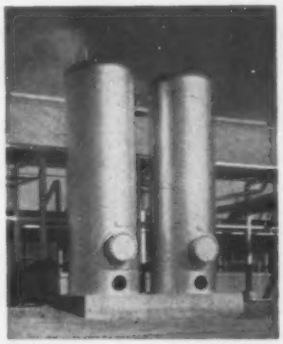
Stabilizers

Pressure Vessels

We invite you to visit Flint's all new Tulsa plant.

GASOLINE PLANT, OIL REFINERY and CHEMICAL PROCESSING EQUIPMENT

For over forty years FLINT **has been** one of the largest and best equipped fabricators of **Process Equipment** for the Petroleum & Chemical Industries.

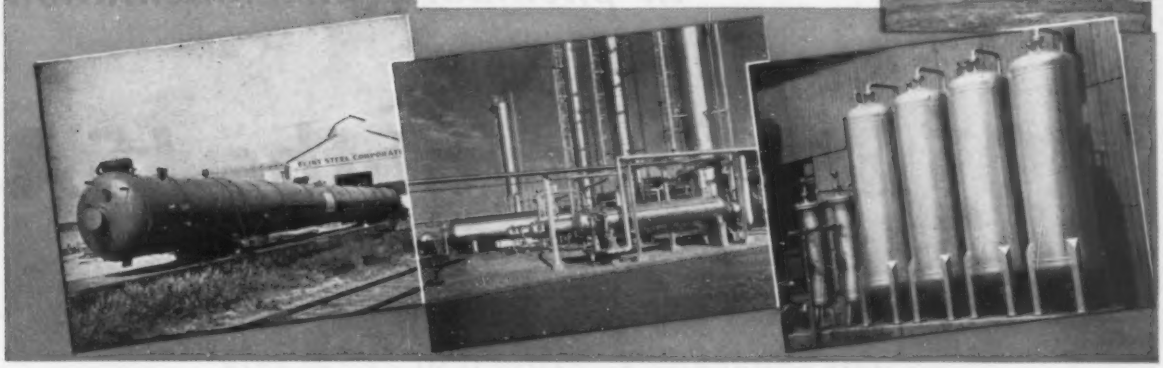


Roll capacity is 1¾" or 2" thick plate. Flint also has Radiograph and stress relieving equipment.

API-ASME or the ASME CODE for Unfired Pressure Vessels is complied with readily.

Stress relieving furnace is 15′ 2″ wide by 85′ long.

The manufacturing facilities of the two Plate Shops with their machinery and equipment make Flint one of the largest fabricators of steel plate products for the Processing Industries in the country.



STEEL PLATE FABRICATORS ASSOCIATION

FLINT STEEL CORPORATION

TULSA ..... MEMPHIS

For more data on advertised products, use Readers' Service Cards, last page.

SEE THE NEWEST AT

Taylor Instrument Companies will present

an Advanced Showing of a new line of

ELECTRONIC INSTRUMENTS

as well as the latest advancements

in pneumatic instrumentation

. . . at the ISA

Taylor Instruments

THE TAYLOR BOOTHS

The new line embodies the latest concept in electronic instrument design, while incorporating many time-proven convenience features originated by Taylor, such as front adjustment, plug-in components and truly rectilinear charts.

Also the TRANSCOPE* Controller and Recorder — pace setters in the pneumatic field — mark a giant step forward in compactness, convenience and performance.

Plus the SENSAIRE* Temperature Transmitter — hailed as an outstanding development in more economical pneumatic instrumentation.

Key representatives from our Application Engineering and Sales Departments will be on hand at the Show to counsel you with your instrumentation problems. And if you have branch plants overseas, you will be interested to learn of Taylor's recently expanded facilities — and our plans for further expansion.

Taylor Instrument Companies, Rochester, N.Y.,
and Toronto, Ontario.

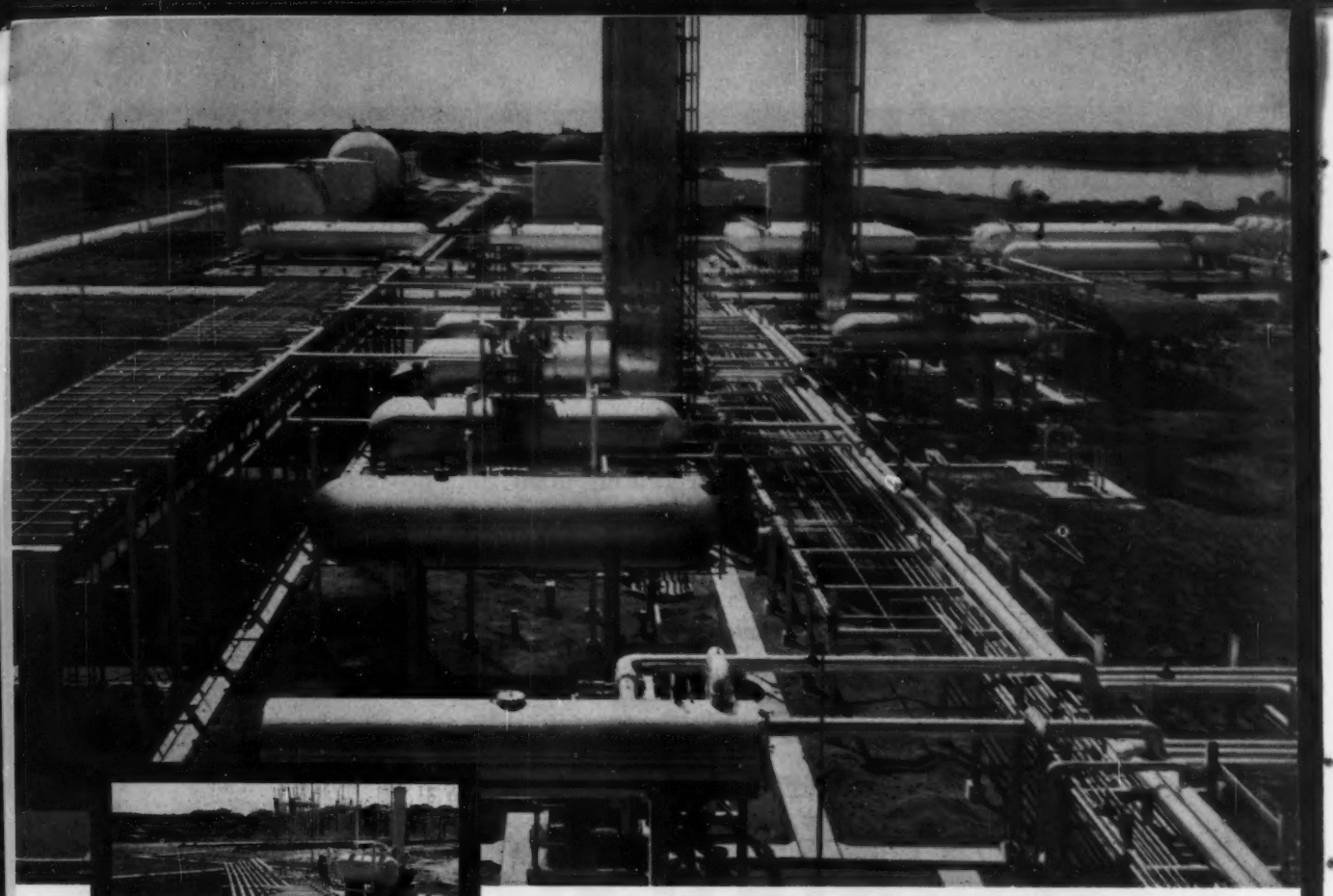
*Trade-Mark

Show, Booths 916 and 1017

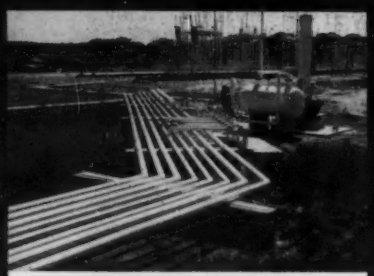
VISION • INGENUITY • DEPENDABILITY

MEAN ACCURACY FIRST

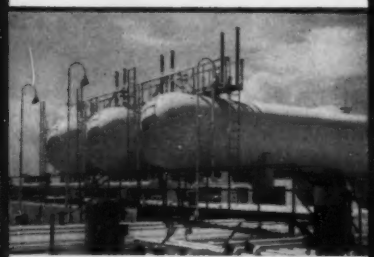
For more data on advertised products, use Readers' Service Cards, last page.



Three-coat systems of Normal Copon self-cleaning white tank coating and three-coat systems of Normal Copon aluminum tank finish were used to protect this fractionating plant of The Bay Petroleum Corp. (a subsidiary of Tennessee Gas Transmission Co.).



Copon pipe coatings provide thicker films per coat for extra protection of seams, welds, sharp edges and other trouble spots.



Copon tank coatings remain tough and elastic when subjected to heat, high humidity and chemical fumes.

tanks stay whiter, brighter... protected by Copon coatings

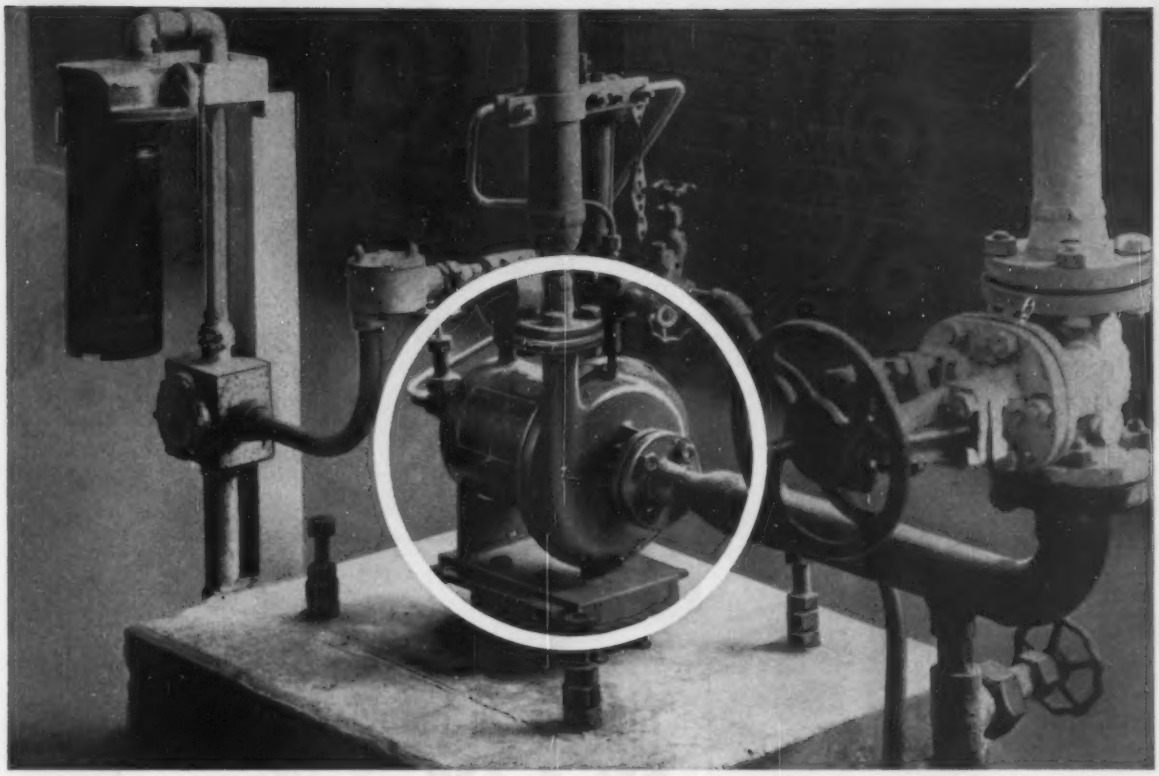
Coatings of Normal Copon provide superior protection for tanks, pipes, and miscellaneous plant equipment. They cling tenaciously to metal surfaces, withstand the expansion and contraction of metal, and provide longer-lasting film integrity to assure permanent corrosion protection. Expensive surface preparation is not required when Copon-protected tanks are repainted, and Copon Coatings have the slowest rate of erosion in the industry.

Copon®

FOR CORROSION CONTROL

For complete information on Copon write on your company letterhead to the manufacturer located nearest your city.

BENNETT'S	65 W. First South St., Salt Lake City, Utah
WALTER N. BOYSEN CO.	42nd and Linden Sts., Oakland 8, Calif. 2309 E. 15th St., Los Angeles, Calif.
BRITISH AMERICA PAINT CO., LTD.	P. O. Box 70, Victoria, B. C., Canada
BROOKLYN PAINT & VARNISH CO., INC.	50 Jay Street, Brooklyn 1, N. Y.
COAST PAINT & LACQUER CO.	P. O. Box 1113, Houston 1, Texas
COAST PAINT & LACQUER De MEXICO, S. A.	Apartado Postal No. 9637, Mexico, D. F.
ENTERPRISE PAINT MANUFACTURING CO.	2841 S. Ashland Ave., Chicago 8, Ill.
INDUSTRIAL PAINT MANUFACTURING CO.	P. O. Box 2371, Birmingham 1, Alabama
E & F KING AND COMPANY, INCORPORATED	640 Pleasant Street, Norwood, Mass.
KOHLER-McLISTER PAINT CO.	P. O. Box 546, Denver 1, Colo.
McDOUGALL-BUTLER CO., INC.	2929 Main St., Buffalo 14, New York
MULSYN PAINT & CHEMICALS	64-70 Hanover Street, Fitzroy, N. 6, Melbourne, Aust.
JAMES B. SIPE and COMPANY, INC.	P. O. Box 8010, Pittsburgh 16, Pa.
SOCIETE DES VERNIS PYROLAC	51 Rue De Lechat Creteil (Seine), France
WILBUR & WILLIAMS COMPANY	130 Lincoln Street, Boston 35, Mass.



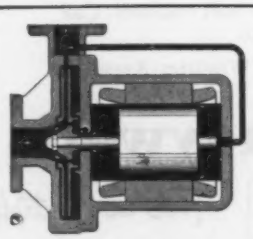
Chempump prevents H_2S leakage

in refinery service at Socony Mobil Oil Co.

This explosion-proof *Chempump* handles an H_2S water solution in a DEA scrubbing operation at Socony Mobil Oil Company's Trenton, Mich. refinery. It was installed a year ago to replace a conventional centrifugal pump. In a full year of zero-leakage operation, the *Chempump* has required no maintenance of any kind.

Chempump is absolutely leakproof because it is a totally enclosed unit. It has no seals, no stuffing box, no packing. External lubrication is never required—bearings are constantly lubricated by the pumped fluid itself. Maintenance is limited to an occasional inspection and replacement of bearings.

These and other *Chempump* advantages could well provide the answer to a pumping problem in your own plant. For details concerning your specific application, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.



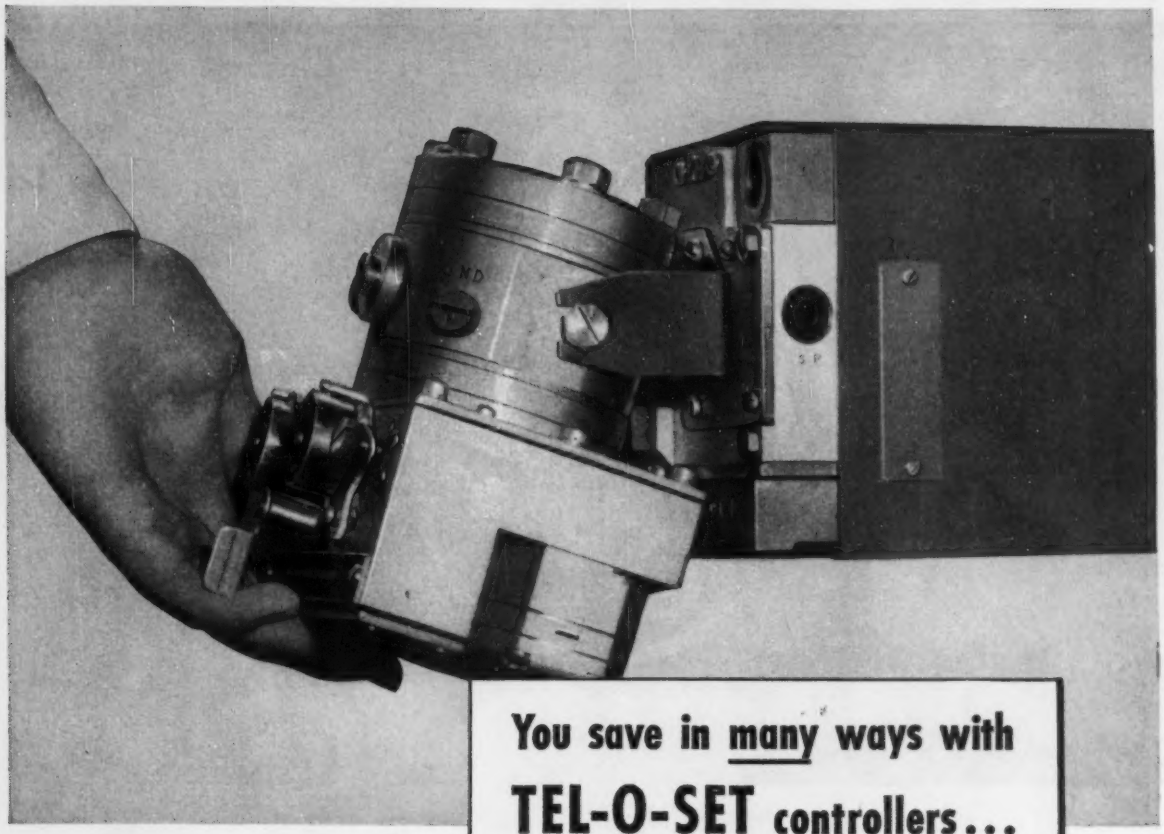
Chempump combines pump and motor in a single, leakproof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

Chempump

First in the field...process proved

For more data on advertised products, use Readers' Service Cards, last page.



You save in many ways with TEL-O-SET controllers...

... today's most advanced pneumatic controllers

Control any process variable with a simple yet highly sensitive *Tel-O-Set* controller. Get all the high-performance characteristics you expect from a modern controller . . . plus specific savings.

CUT INSTALLATION COSTS

- Quick-connect assembly makes controller mounting easy.
- Mounting manifold preserves quick-connect and bumpless transfer features.

CUT SPARE PARTS INVENTORY

- Only one basic controller needed for all applications.
- Add rate action easily for more complex processes.

REDUCE PROCESS DOWNTIME

- Process remains on manual control when controller is removed.
- Unique design eliminates start-up overshoot.

SAVE MAINTENANCE

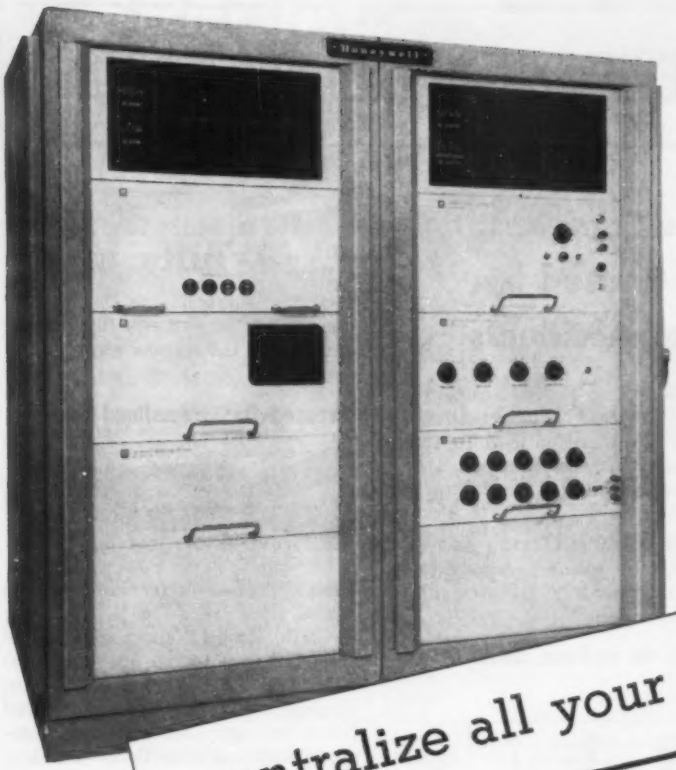
- Foolproof reassembly after cleaning and servicing.
- Repairs easily made by any maintenance man.

Get complete details on controllers and other *Tel-O-Set* instruments from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls



centralize all your process data

with Honeywell's new Data Handling System

SIMPLIFY DATA PROCESSING . . . eliminate the complexities you associate with gathering and correlating data.

GAIN NEW DATA PROCESSING FLEXIBILITY . . . change logging sequence at will . . . easily switch types or ranges of inputs . . . add inputs quickly . . . move smoothly from one process to another. Here is a system that defies obsolescence.

GAIN GREATER ACCURACY . . . process data with accuracy of 1/10 of 1% of *reading*—accuracy that's *barely approached* by other data processing equipment.

GAIN DEPENDABILITY . . . all components of Honeywell's new Data Handling System are designed for remarkably long life and utmost operating efficiency . . . maintenance needs are pared to a minimum.

SIMPLIFY OPERATION . . . span, range, zero and alarm points are set to the actual digital value by merely placing a few pins in a board.

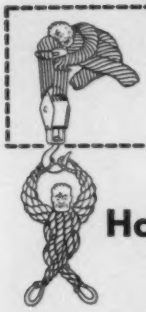
CUT MAINTENANCE TIME . . . the Honeywell Data Handling System can be serviced while in operation—an exclusive advantage.

Write or call for details.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Products Group*, Brown Instruments, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls



Tuffy. Tips On

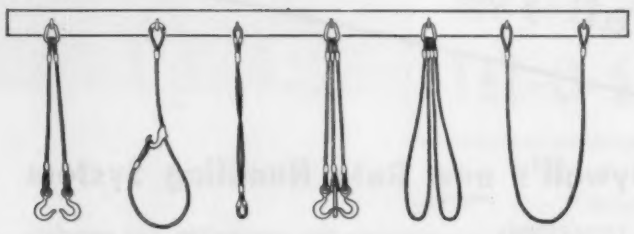
SAFE USE OF SLINGS AND HOIST LINES

Half of All Workmen's Compensation Cases in Ontario Caused by Materials Handling Accidents

Officials of the Workmen's Compensation Board at Toronto recently reported that 50% of compensation cases in 1956 (excluding accidents in which workmen were struck by something) were caused in materials handling work. Back injuries totaled 16.7% of compensated cases. Medical aid and compensation for back injuries added up to $4,520,000.

That's a high price to pay, in human disability and suffering as well as in dollars, for avoidable accidents. It can be greatly reduced if safe methods of materials handling are more widely adopted and more diligently applied.

Here are some of the things you can do to reduce hazards of faulty equipment and operation:



Safety Begins with "Good Housekeeping"

Too often, slings are dumped in a corner of a storeroom after use. When they're needed again, it's difficult to untangle them and the wrong sling is chosen because it is easiest to get to. Shown here is a rack which makes orderly storage easy. Such tidiness makes for greater efficiency and safety all around.

1. **Keep slings,** ropes, chains, and cables in orderly storage when they're not being used. Such equipment can be damaged between lifts if it is left in haphazard piles.
2. **Don't allow** hitching equipment to remain loose on crane hooks, hoists and loads when not in use.
3. **Check hitching** equipment before using. Inspect it again before return to storage.
4. **Shake out** kinks and twists **to prevent kinked slings** before loading slings. Never use a kinked sling. Remember it is next to impossible to kink a Tuffy Sling in normal use; and when kinks do occur, they can be smoothed out with no serious damage.
5. **Make sure** crane and hoist controls are in best working condition. Test all equipment frequently.

FREE! Tuffy Sling Handbook

Gives complete data on Tuffy Slings — types, dimensions, weights and rate loads. Plus a complete rigger's manual and engineers notebook on wire rope constructions and specifications. Write for your copy now.

You're On the Safe Side With Tuffy. Slings

Maximum safety is one of the many benefits you get in Tuffy Slings. Here are some of the reasons why:

Pressed-On Streamlined Ferrules

Tuffy's pressed-on ferrule gives the tucked eye splice 100% of fabric strength. Applied under great pressure, the steel ferrule literally flows into spaces between wires and strands, developing friction force equal to full fabric strength. Streamlining eliminates snags and projections that might injure hands.

Tuffy's Exclusive Fabric

Only Tuffy gives you the exclusive, patented, machine-braided fabric that combines extra strength and flexibility never before built into any sling. It makes knotting and kinking next to impossible, and if kinks do occur they are easily smoothed out.

Your Tuffy Distributor Will Help You Save Money

He's stocked to give you fast delivery on Tuffy Slings, Hoist Line and other Union Wire Rope. The longer life and greater safety of Tuffy can reduce your operating costs. Get in touch with your Tuffy distributor now.

union Wire Rope corporation

SUBSIDIARY RMCO STEEL CORPORATION

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand

2284 Manchester Ave. **Kansas City 26, Missouri**

For more data on advertised products, use Readers' Service Cards, last page.

SPECIAL FITTINGS Need *NOT* Delay You

Entire interior and exterior surfaces of special stainless elbows for nuclear power plant are inspected with dye penetrant in search of microscopic surface imperfections. Elbows are 16" O.D. with 102° included angle and long tangent on one end.

Midwest Can Make *and* Deliver

An exclusive and flexible manufacturing process enables us to make welding fittings of any material available in plate that can be worked and welded. As plate is more readily available than pipe, in special materials and thicknesses, deliveries are much better.

Elbows with special included angles, special tangents, special wall thicknesses and of special materials are easily and promptly made. Closer tolerances are inherent in the Midwest process. Quality control always exceeds code requirements . . . can be as comprehensive as you need.

Whether or not you use specials, Midwest Welding Fittings will do a better job for you. Consult your distributor, or write us for new Bulletin 5801.

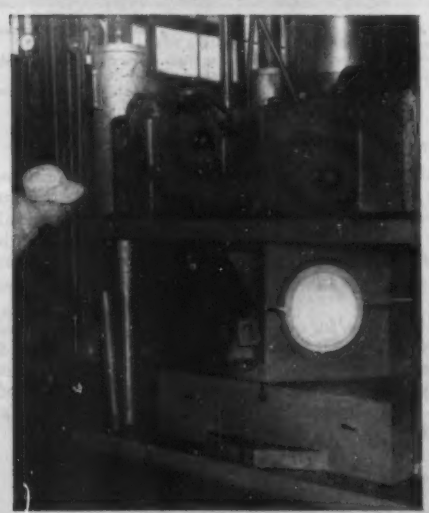
MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Mo. (P. O. Box 433)
PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

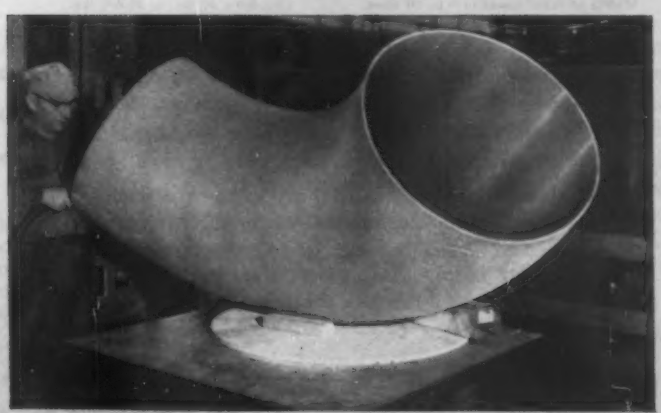
SALES OFFICES:
Asheville, (Box 446, Skyland, N. C.) • Atlanta 9–72 11th St., N.E.
Boston 27–426 First St. • Chicago 3–79 West Monroe St.
Cleveland 14–616 St. Clair Ave. • Houston 2–1213 Capitol Ave.
Los Angeles 33–520 Anderson St. • Miami 34–2103 Le Jeune Rd.
New York 7–50 Church St. • Pittsburgh 19, Pa.–437 Grant St.
San Francisco 11–420 Market St.
St. Louis 4, Mo.–1450 South Second St. • Tulsa–1640 E. 21st St.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

Note the exceptionally long tangent on one end of this 36" O.D. 90° short radius elbow made of special carbon steel. Similar tangent could have been provided on other end if required.



18" O.D. x 1¼" wall 90° elbows (2¼% chrome ½% moly) being sized in compression by totally enclosing dies. The exceptional dimensional accuracy that results is possible only with the Midwest process.



Interior surface of 30" O.D. stainless steel welding elbow for liquid sodium nuclear system required a finish of 125 micro-inches or better.

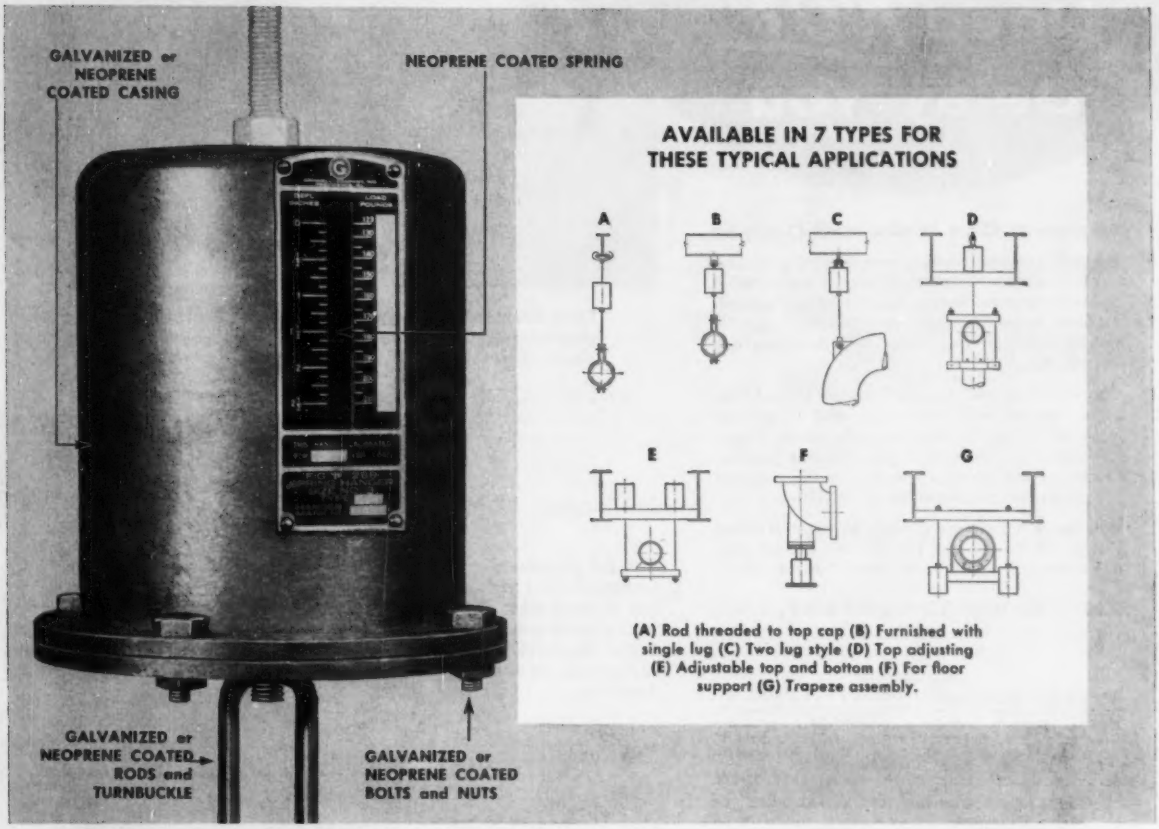
8060

MIDWEST WELDING FITTINGS

IMPROVE PIPING DESIGN and REDUCE COSTS

corrosion-resistant, weather-resistant

GRINNELL VARIABLE SPRING HANGERS


GALVANIZED or NEOPRENE COATED CASING
NEOPRENE COATED SPRING
GALVANIZED or NEOPRENE COATED RODS and TURNBUCKLE
GALVANIZED or NEOPRENE COATED BOLTS and NUTS
AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS
A
B
C
D
E
F
G
(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

In addition to their proven corrosion and weather resistance, these spring hangers offer other features.

- Maximum variation in supporting force for standard spring models per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression (a patented feature) assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.
- 21 sizes available from stock for load ranges from 50 lbs. to 28,200 lbs.
- Available in 3 spring lengths for maximum travel of 1¼, 2½, and 5 inches.
- Installation simplified by integral load scale and travel indicators.
- All-steel welded construction meets pressure piping code.

For hanger installations which are subject to highly corrosive industrial conditions — or where exposed to severe weather, Grinnell makes available two distinct lines of pre-engineered spring hangers.

These hangers are the result of extensive experimentation with various coatings for Grinnell's standard pre-engineered spring hangers. In addition to providing flexibility in pipe suspension, they provide versatility of application through their corrosion-resistant characteristics.

1. NEOPRENE COATED — for highly corrosive conditions, such as those found in chemical plants and refineries. All parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives. The flex life of the spring is unaffected by the neoprene . . . the coating resists cracking or flaking over a wide temperature range.

2. GALVANIZED — for outdoor installations, where weather conditions are severe. All parts of the hanger are galvanized except the spring, which is neoprene coated to avoid alterations of temper, hydrogen embrittlement and decreased flex-life of the spring — usual hazards to springs from the galvanizing process. Write for further details.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.

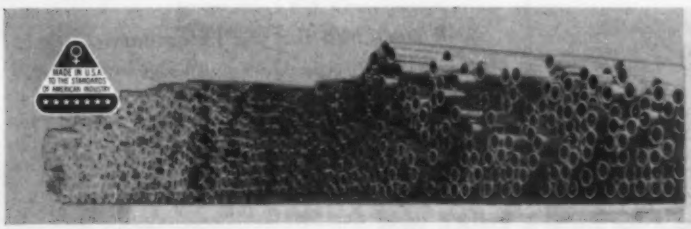
MADE TO TAKE IT!

CHASE® HEAT EXCHANGER TUBES

Refinery service is rough—but Chase Antimonial Admiralty Heat Exchanger Tubes are made to take it! They resist corrosion break-down, withstand high temperatures, stand off water-borne impurities and the attack of "sour" crudes and additives.

Good strength and hardness, high thermal conductivity and excellent resistance to fatigue, wear and abrasion assure you of longer service, less down-time, far fewer replacements.

Field stocks are available in Tulsa (Vinson Supply Co.), Houston (Standard Brass & Mfg. Co.), Denver, New Orleans and Los Angeles; mill stocks on hand in Cleveland. If you need heat exchanger tube engineering service, let us know—we'll be glad to send our special consultant to help you with specific recommendations on handling your heat exchanger tube problems. Ask your nearest Chase District Office, or write Chase at Waterbury 20, Conn.



Chase®
BRASS & COPPER CO.
WATERBURY 20, CONNECTICUT
Subsidiary of **Kennecott Copper Corporation**

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York (Maspeth, L.I.) Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury

For more data on advertised products, use Readers' Service Cards, last page.

Designed for the Petrochemical Industry

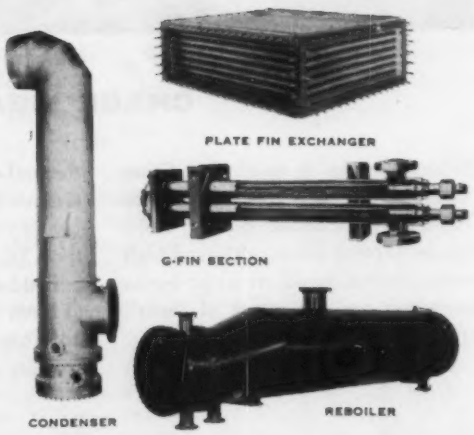
Proved in over 500 installations

Griscom-Russell fin-fans, by eliminating the cost of water, pumps, piping, valves, water treatment and maintenance, are the economical heat exchangers for many petrochemical cooling and condensing services.

G-R **fin-fans** are designed of the highest quality components to fit your special application. The transfer area is made of G-R's strong, helically finned tubing for highest efficiencies. Exceptional design and pre-fabricated construction minimize installation and maintenance expenses.

fin-fans are available in forced or induced draft designs with a wide range of capacities. Many accessories are available to solve special drive, control and weather problems.

Send for Griscom-Russell Bulletin 2400.



G-R Designed for the Petrochemical Field

Reboilers • G-Fin Sections • Condensers • Plate Fin Exchangers • Longitudinally and Helically Finned Tubing • Bentube Evaporators • Liquid Heaters • Tubular Heat Exchangers • Solution Heaters • Oil and Water Coolers • Tank Heaters • Gas Coolers • Bentube Sections

HEAT EXCHANGE EQUIPMENT FOR THE PETROCHEMICAL INDUSTRY

GR 380

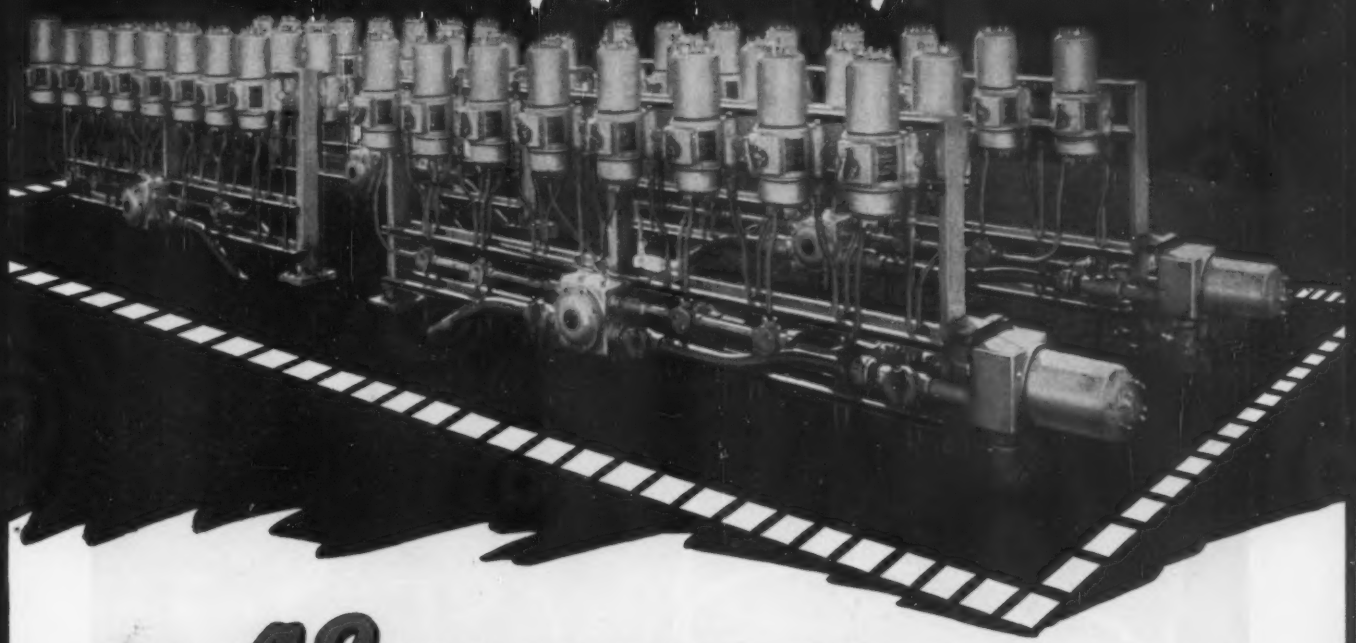
Griscom-Russell

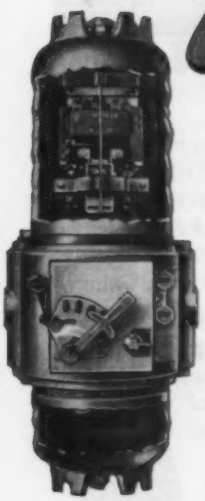
GENERAL PRECISION EQUIPMENT CORPORATION GPE

THE GRISCOM-RUSSELL COMPANY • MASSILLON, OHIO

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

CROUSE-HINDS
Condulet* motor controls
Occupy Less Space!





48 **Explosion-Proof Combination Motor Starters and Circuit Breakers . . . *in a 25 ft. x 6 ft. Area!***

Crouse-Hinds Condulet* Type EPC Motor Starters and Circuit Breakers are explosion-proof, dust-tight (dust-ignition-proof) and weather-resistant (raintight).

Lightweight cast aluminum construction for easy installation without use of lifting equipment.

Seven Conduit entrances simplify installation.

Built-in push button stations and selector switches are available.

Starter sizes 0 to 5. Circuit breakers 50 to 600-amp. frame sizes.

In the installation shown above, 48 Crouse-Hinds Condulet* Type EPC combination motor starters and circuit breakers are compactly arranged in four racks.

If necessary, the 25 ft. x 6 ft. area used could have been cut in half by installing the Condulet motor controls in two tiers. Or, *twice* as many Condulet controls could have been installed in the same area, if required.

The *vertical design* of Crouse-Hinds motor starters, circuit breakers and combinations allows them to be installed only ¼" apart. This compactness produces savings in the construction of steel mounting racks, and in the use of premium floor space.

● **For help in solving a space problem, see your Crouse-Hinds distributor . . . or call the nearest Office listed below**

*Registered

A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

CROUSE-HINDS COMPANY

Main Office and Factory: Syracuse, N. Y.

NOW...WELD OR BRAZE FOR FASTER, LOWER COST PROCESS LINE ASSEMBLY

Speedline® ALIGNING CONNECTORS ALSO INSURE POSITIVE PIPE ALIGNMENT

No pipe misalignment or "icicles" at joints with Speedline Stainless Steel Aligning Connectors. This inexpensive connector fits over stainless pipe and *Speedline Fittings*, to permit speedy welding or silver brazing of tight, leakproof, socket type joints. In-place preassembly for positive alignment *prior* to welding or brazing, reduces installation time and costs for the most complicated process piping systems.

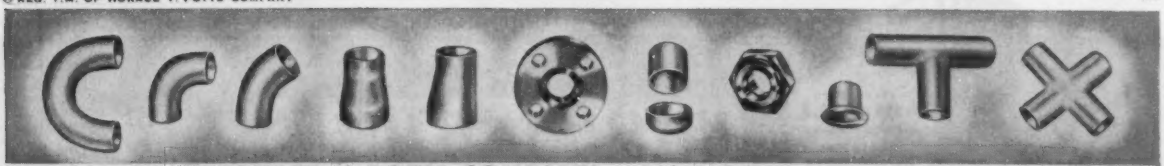
Speedline Aligning Connectors also make it easy to tie in low cost, light wall Schedules 5 or 10 stainless pipe and *Speedline Fittings* with existing heavy wall lines. The extra straight section on *every* end of *every* Speedline corrosion resistant fitting allows for *direct* assembly of Aligning Connectors to any or all ports of the fittings.

Learn how Speedline Aligning Connectors and the *complete line* of Speedline stainless steel fittings can provide process piping economy and efficiency never possible with conventional fittings. Write for a copy of "Speedline Catalog" today, at no obligation.

Speedline® **STAINLESS STEEL FITTINGS**
THE NEWEST THING IN PIPELINE ECONOMY

® REG. T.M. OF HORACE T. POTTS COMPANY

917



Manufactured by **HORACE T. POTTS COMPANY** • 566 E. Erie Avenue • Philadelphia 34, Penna.

40% 40% 40%

MORE WATER

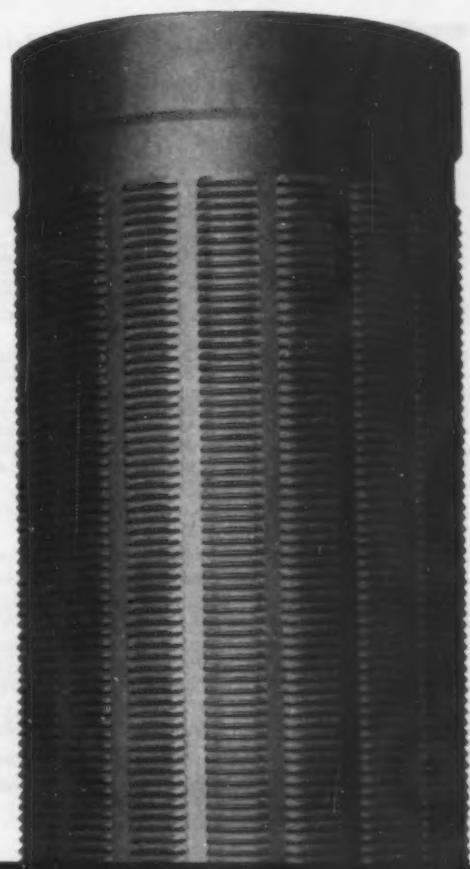
can flow through the NEW Layne 134 shutter screen

WHY? *Increased inlet area!*

Here's a screen that is even more efficient . . . has *greater strength* than the long-lasting Layne 96 shutter screen that made Layne water wells famous.

This new development of Layne creative research is used only in Layne water well installations, and available exclusively through Layne Associate Companies.

Contact your nearest Layne Associate Company for complete details.



LAYNE & BOWLER, INC. MEMPHIS
General Offices and Factory
Memphis 8, Tenn.

Layne Associate Companies throughout the world.

WATER WELLS
VERTICAL TURBINE PUMPS • WATER TREATMENT

Will you reap the long-term payoff
of good mixer shaft sealing?

If you want to minimize your mechanical fluid mixing costs, take a hard look at *mixer shaft sealing.*

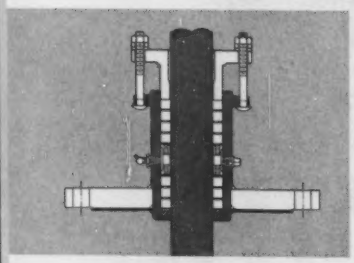
This is the area where profits can leak away unnoticed. The right shaft seal makes all the difference between an efficient mixing operation and a ruinously expensive one.

When you're aiming for low-cost shaft sealing, *don't be fooled* by low first cost. Instead, look for solid long-range savings you can make in terms of *smooth operation, rapid maintenance, minimum downtime.*

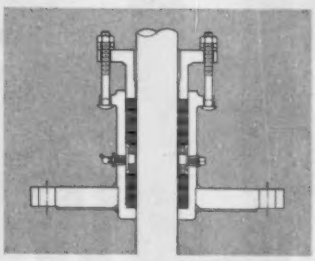
Here are some mechanical reasons why you get these savings with LIGHTNIN Mixers. Every one of the features illustrated below is a LIGHTNIN "first." Many are yours only with LIGHTNINS. And only LIGHTNINS give you *all* of them!

For lowest-cost fluid mixing, see your LIGHTNIN Mixer representative soon. Look him up in Refinery Catalog. Or write us direct.

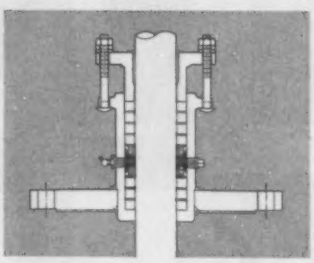
How you cut mixing cost with the *Lightnin* stuffing box



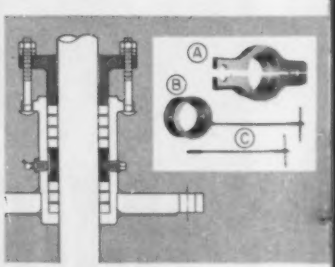
1. SAVE COST of a special-alloy mounting flange with all-welded LIGHTNIN construction. Forged steel flange is faced with correct alloy for your process conditions. Hub is solid alloy. Alloy parts are shown in gray.



2. GET SUPERIOR SEALING with 7 rings of large-cross-section packing. Separators facilitate packing removal, distribute force uniformly. Gland bolts, threaded part way, prevent overtightening.



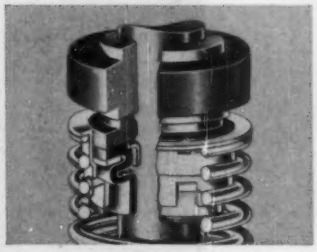
3. GET BETTER LUBRICATION without repacking. Lantern ring evenly distributes lubricant; permits continuous lubrication under pressure; extends time between repackings. Relief plug prevents overlubrication.



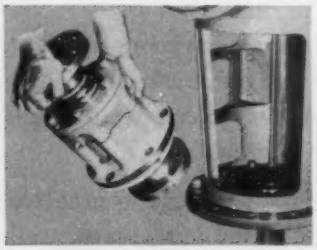
4. REPACK FASTER with exclusive split packing gland (A) that comes right off the shaft to allow maximum work space. Lantern ring (B) lifts out quickly by means of pullers (C), standard accessories.

Get simplest possible maintenance with *Lightnin* mechanical seal*

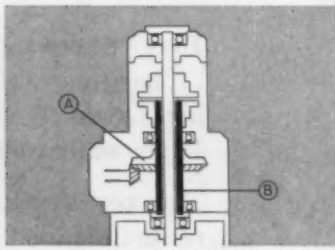
1. ELIMINATE REPACKING and adjustment with this cartridge-type LIGHTNIN rotary mechanical seal assembly, optional on all LIGHTNIN Mixers. It's saving many users thousands of maintenance dollars a year.



2. GET WIDEST CHOICE of seal designs and materials to meet your conditions: stainless steels, Stellite, Hastelloy alloys, bronze, ceramic, Teflon, etc. Handle pressures to 2500 psig and all temperature ranges.



3. REPLACE SEAL ASSEMBLY quickly, if ever necessary—without dismantling mixer or removing it from tank, and *without skilled manpower.* Seal cartridge unbolts, comes out as a unit; replacement bolts in.



4. RETAIN GEAR ALIGNMENT when changing seal. Mixer gears (A) are isolated from shaft by hollow drive quill† (B) —*cannot get out of line* when seal is removed. Shaft realignment is automatic on reassembly.

†patented

WHAT MIXING OPERATIONS are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-j Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

*patent pending

Front and Center for Oil's Oldtimer

"IT'S MORE than a week-a-year job" PETROLEUM REFINER told you in its lead editorial last month when we took occasion to remind our readers that very soon now we will be observing Oil Progress Week—seven important days when our great industry makes a special effort to tell its story to the public. Individuals engaged in this industry, we reminded you then and repeat now, at that time have a bounden duty to tell their friends and neighbors about oil, and particularly to answer some of the points of criticism that are all too rampant.

In this connection we're selecting this month an all but Forgotten Man of the oil industry, Johnny Coal Oil whom we will put front and center with a few facts that will give a lot of you a better appreciation of his current role. Purpose here, of course, is our hope that you will learn some facts of interest and value and that you will add these to the store of other information needed in the disseminating job to which each of us has been assigned October 12-18.

Most people feel the demand for kerosine dropped sharply when Edison came forward with his light bulb and that the downward trend started then has continued apace. So it's going to astonish many of those outside the oil industry, and not a few within, when we point out that actually the demand for kerosine is on the increase.

None will argue, of course, but that we have come a long way since the days when kerosine was used almost exclusively for lamp fuel. But let's not forget that Johnny himself is an old friend who can rightfully be called one of the founding fathers of the oil industry. There was a time, you will recall, when the value in a barrel of crude oil was fixed as to its kerosine content.

The famous report by Professor Benjamin Sillimin which has been called "a chemical classic that touched off an industry" was performed primarily to see whether or not petroleum could be used as an illuminant. As a matter of fact, this report was entitled "Report on the Rock Oil, or Petroleum from Venango Co., Pennsylvania." Then right after that Professor Silliman wrote, "With Special Reference to Its Use for Illumination and Other Purposes."

In Wide Use Today. A recent issue of "Oil Progress," publication of California Texas Oil Co., Ltd., contained some revealing facts about the uses of kerosine. For instance, in the United States, the most industrialized nation in the world, four million rural homes use kerosine for cooking, heating, and light.

Just about anywhere you would care to go in the world it would be difficult to elude the influence of kerosine. In Hong Kong, for example, a unique battle for supremacy in the colony's kitchens is underway this very hour between stove kerosine and locally grown firewood which has reigned supreme for many years.

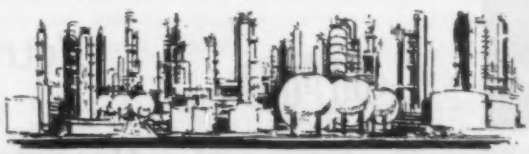
Skipping across to Europe, we see Dutch peddlers loading their pushcarts with 55-gallon drums of kerosine and setting out on their daily rounds. Just like the milkman in this country, each Dutch peddler has a definite territory to cover where he makes regular deliveries to his customers in one-liter cans. At each stop the peddler normally delivers one full can and brings back an empty, for thrifty Dutch housewives rarely buy more than one liter at a time.

But in addition to these traditional functions, there are many new industrial applications in which kerosine is proving itself more valuable than ever. For instance, how many people realize that the fuel which powers a screaming jet through the sonic barrier is essentially the same as that which has burned quietly in the humble kerosine lamp for many years?

And if that doesn't astonish some of your acquaintances try asking them if they realize the fuel which is used in the first stage of the Vanguard rocket is nothing more than an improved descendant of what grandad used in his buggy lamp. That's right, it's our old friend Johnny Coal Oil. Because kerosine provided the initial thrust for the rocket that put our first Vanguard satellite into orbit.

(Continued on Page 203)

TODAY—OIL BUILDS
for your TOMORROW!



OIL PROGRESS WEEK OCTOBER 12th—18th

Du Pont FOA-2 is added to residual fuel as it's pumped into sludge-ridden tank.

$20 worth of FOA-2 saved $800 desludging job ... and with no downtime

A power plant serving two industrial laboratories burns between 1,000 and 1,500 gallons of residual fuel, daily, from a 50,000-gallon tank.

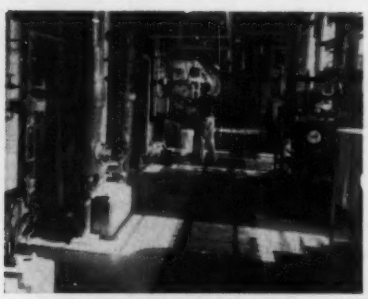
Recently, it was discovered that six inches of sludge had accumulated in the bottom of the tank. Constant temperature had to be maintained in the laboratories, so a tank-cleaning firm was called in. They gave a firm estimate of $800 for cleaning the tank mechanically. Considerable downtime would be required.

Looking for an alternative, the power superintendent decided to try using Du Pont Fuel Oil Additive No. 2 to break down the sludge. After one week of operation, during which only $20 worth of FOA-2 was used, no sludge could be detected. Moreover, there was no downtime. *The tank was in use all during the clean-up period.* Boiler room operations were completely trouble-free throughout the time the sludge was being dispersed and burned with the oil.

In addition to sludge removal, prevention of sludge is an improvement FOA-2 gives residual fuels. It is an excellent stabilizer, solubilizer, and dispersant.

Being nonmetallic, the additive burns with the fuel, leaving neither ash nor other residue. Refiners as well as their customers profit from the use of FOA-2, because it helps to stabilize all forms of distillate fuel oils, as well as residual fuel. These include blends such as catalytic-cracked stocks combined with straight-run products.

Your Du Pont representative can give you further details. Or write for a copy of our comprehensive 24-page FOA-2 book. It contains complete technical and experimental data. E. I. DU PONT DE NEMOURS & CO. (INC.), Petroleum Chemicals Division, Wilmington 98, Delaware.



This is the powerhouse that *had* to maintain service, so that essential temperature control, in the laboratories it served, could also be maintained.

DU PONT

Better Things for Better Living
. . . through Chemistry

Tetraethyl Lead
and other
Petroleum Additives

(Continued from Page 201)

Unglamorous Jobs, Too. There are other new uses too for kerosine. Perhaps some of them aren't as exciting or as glamorous as the two jobs just mentioned, but they certainly are important. For instance more and more industrial products such as insecticides, cut-back asphalts, paints, polishes, cleaning and de-greasing compounds and gas-absorption oils include kerosine as an ingredient. Also, many power tractors and farm machines burn kerosine in their engines.

Perhaps one of the most amazing growths of the kerosine market in recent years has been in the tobacco-raising areas of southeastern United States. Here kerosine heaters have replaced wood-burning stoves for curing tobacco at such a rate that summertime consumption of the fuel ranges up to 50 times what it was a few years ago.

Oil Progress Week will be filled—and rightfully—with much talk about fuel oil, high octane gasoline, petrochemicals and many more of petroleum's wonderful products. But let's not forget to say a good word or two for kerosine, over the years a real workhorse of our industry.

Average Isn't Good Enough

WHAT, IN THIS DAY AND TIME, would it take to spark American scientists and other leaders into moving as fast and efficiently in peacetime as they do in war?

If we could answer that poser we would in time, rank high among those who have made a definite contribution to a nation's future welfare.

The fact that we have not come up with a solution, however, puts us in a great big boat with a lot of other people. For example, Crawford H. Greenewalt, president of E. I. du Pont de Nemours and Company, in a recent talk before the American Institute of Chemical Engineers discussed this as posing one of the country's biggest needs.

War as we know all too well, Greenewalt contends, is completely futile, destructive, and immoral —but we must also admit that it inspires high personal courage, great daring and superhuman accomplishments. This has to be the case, as war is a contest where the winner takes all, and in the past, this country has been able to survive only by tapping the hidden resources of mind and spirit which are necessary toward the accomplishment of extraordinary performances.

While it is true we have witnessed recent advances in atomic energy, high speed aircraft and the launching of earth satellites, we must also remember that these deeds were accelerated by pressures beyond normal peacetime routine.

Of course there is a certain "spiritual satisfaction" Greenewalt contends, which results from doing a good job—and this tends to motivate some people to a certain degree. However, that "inner glow associated with a job well done can all too easily become a resting place for ambition and a quiet backwater in which to relax. For the question is not only whether we are doing an adequate job, but whether or not we are using to maximum effect the abilities with which we were endowed."

We have only to pick up a newspaper and read what is going on in the world to see that if this country is to retain its position as one of the great powers, we cannot afford to slowdown.

America is not an average nation—so we should be unwilling to settle for average technological accomplishments.

In what manner though can we "tap the hidden resources of mind and spirit necessary to extraordinary performance" so badly needed?

A Nation's Real Bulwark

"WE ARE THE GREATEST country in the world. We have the greatest amount of freedom. Our corporations are the very foundation of our economy. And please don't let the politicians do anything to them."

Stockholders of Standard Oil Company (New Jersey) held their annual meeting in Lawrenceville, N. J. late in May and it was quite a session just as such meetings of all of our big corporations have come to be. It's democracy in action from the opening gong with stockholders speaking their pieces sometimes for but frequently against the views of management.

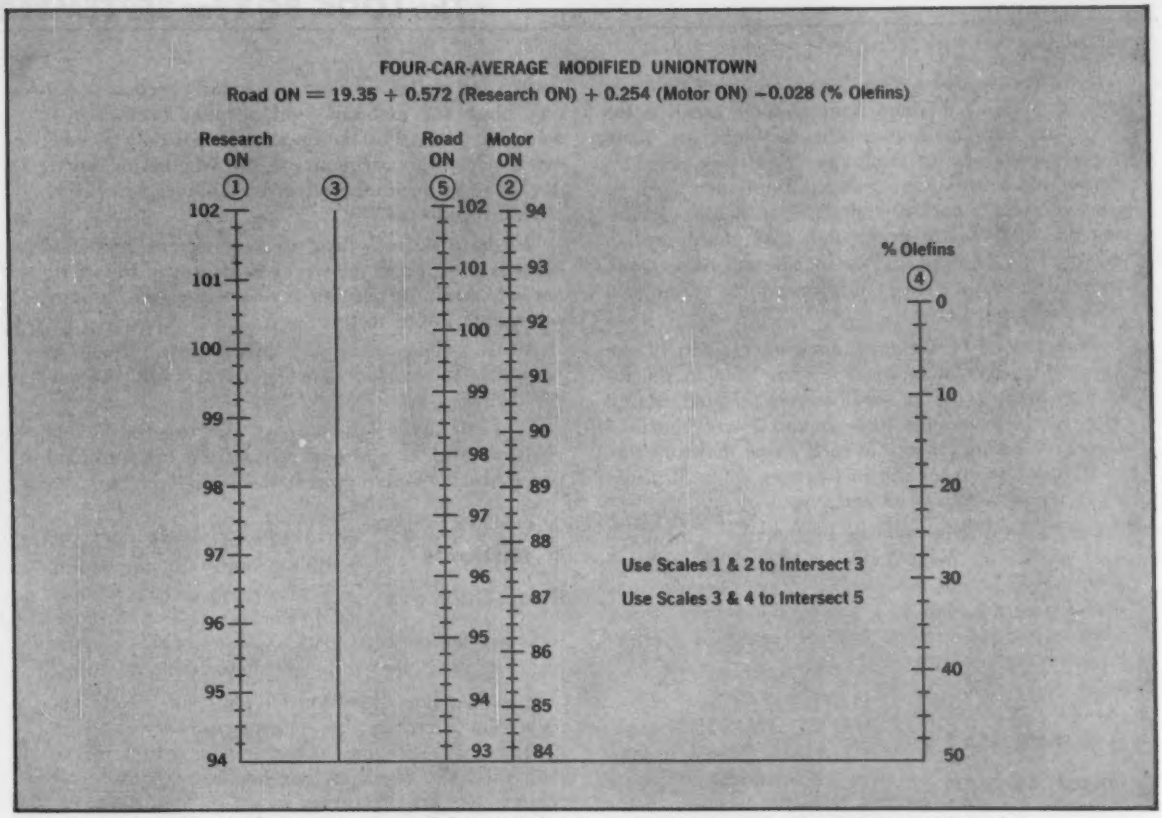
The opening words of this paragraph are excerpted from such a speech, the final one of the Lawrenceville session. The stockholder is not identified by name in the printed report of the meeting, but he—or she—certainly identified himself as being a sound thinker. His thoughts, it occurs to us, were most appropriate as a closing note for a good, old-fashioned American business meeting:

"I should like to bring this fact to the attention of the stockholders. We take our form of government for granted. We don't realize that all of our liberties and opportunities stem from it.

"And as stockholders we take our management and our dividends for granted. If by any chance our government should ever fall, as have the governments of other countries, we certainly would have a problem in connection with our dividends.

"So as we leave this meeting let's just realize we are the greatest country in the world. We have the greatest amount of freedom. Our corporations are the very foundation of our economy. And please don't let the politicians do anything to them."

If Mr. Stockholder's last ten words were directed at company officials, then the chairman should have tossed them right back at the assembled group for the stockholders to share. Because "we, the people" have perhaps a stronger influence on a country's politicians than do its collective business managements.


FOUR-CAR-AVERAGE MODIFIED UNIONTOWN
Road ON = 19.35 + 0.572 (Research ON) + 0.254 (Motor ON) −0.028 (% Olefins)
Research ON
Road ON
Motor ON
% Olefins
Use Scales 1 & 2 to Intersect 3
Use Scales 3 & 4 to Intersect 5

Here is an example nomograph for calculating the road antiknock performance of premium fuels.

Ethyl Research establishes new equation coefficients for calculating road octane numbers of 1958 gasolines

Now, road performance can be predicted for both premium and regular fuels, without the expense and time ordinarily used in road-rating programs

LAST YEAR Ethyl Research Laboratories in Detroit developed a system for calculating road performance of premium fuels from routine laboratory tests.

The work was based on a study of samples, from refineries, representing 75 per cent of the premium motor fuel blended in the United States during 1957.

Extensive computer analyses of test data resulted in a general equation with coefficients that can be selected to cover (1) different makes of cars; (2) Modified Uniontown road ratings; and (3) Modified Borderline road ratings at various speeds.

Ethyl Research has now completed the work of bringing these equation coefficients up to date so that road performance of premium and regular fuels can be calculated for a number of 1958 passenger cars.

A Road Performance Equation

Road performance of gasolines can be calculated from this equation:

$$Y = a + bR + cM + dO$$

where Y = Road octane number
R = Research octane number
M = Motor octane number
O = Per cent olefins
and a, b, c, and d are equation coefficients for a particular car and test.

Coefficients for 1958 Cars

Two publications are available to the refining industry.

They are "Road Octane Correlations for Premium Gasolines 1958," covering tests made on four representative cars, and "Road Octane Correlations for Regular Gasolines 1958," covering tests made on three representative cars.

Appropriate coefficients (a, b, c, and d) are reported for each vehicle to facil-

itate calculation of both Modified Uniontown and Modified Borderline (various speeds) road antiknock ratings.

Also included in each report are average coefficients.

Example coefficients and other pertinent information are shown below for a typical 1958 car. (Table I)

Limitations of Equations

Experience with these equations has shown that their use should be restricted to fuels of similar antiknock qualities and hydrocarbon composition to those used in the original program.

This restriction still allows wide latitude of use, however, since full-boiling commercial gasolines representing current grades were used. (Table II)

Although the road octane numbers assigned to gasolines by one vehicle are not necessarily reproducible in other vehicles of the same make and model, experience has shown that *relative* fuel ratings tend to be quite consistent from car to car.

Ideally, therefore, the equations should be used to compare the road performance of gasolines rather than using them to calculate the road octane number of a specific fuel.

The same reasoning also applies to experimental road-rating results.

TABLE I

Equation Coefficients for a Typical 1958 Car

Road ON = a + b (Research ON) + c (Motor ON) + d (% Olefins)

	a	b	c	d	Std. Error
Modified Uniontown	30.75	0.458	0.263	-0.034	0.36
Modified Borderline					
1650 rpm	27.11	0.637	0.111	-0.029	0.48
2000 rpm	23.57	0.491	0.302	-0.022	0.38
2500 rpm	29.50	0.495	0.229	-0.038	0.32
3000 rpm	22.75	0.498	0.289	-0.047	0.36

Octane Number Requirements

	Modified Uniontown	Modified Borderline 1650 rpm	2000 rpm	2500 rpm	3000 rpm
Primary reference fuels	95.9	96.1	94.4	93.3	92.8
Commercial reference fuels	96.5	96.8	95.0	94.3	95.0

TABLE II

Range of Full-Boiling Premium Fuels

Research Octane Number	96-102
Motor Octane Number	85-94
Sensitivity (RON minus MON)	7-14
TEL, ml per gallon	2.0-3.0
Hydrocarbon Type, vol %	
Olefins	5-50
Aromatics	5-50
Saturates	40-80

How Ethyl Research is helping you

In recent years interest has been continuous within the Oil Industry for effective means to calculate road antiknock performance of gasolines.

As a result Ethyl has two current publications directed toward this interest.

1. "Road Correlations for Premium Gasolines 1958."
2. "Road Correlations for Regular Gasolines 1958."

These publications are one more example of Ethyl's continuing service to the Oil Industry. Copies can be obtained from your Ethyl Representative or by writing Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

•

ETHYL CORPORATION
New York 17, N. Y.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

The Mail Box . . .

About Drafting Practices

To The Editor:

I have carefully reviewed the special report entitled "Six Steps to Better Drafting Practices" (August PR, p. 133) and I am in accord with the entire presentation.

I think you have summed it up very well in the words "the key word is 'simplify' ". Certainly there is a great deal of time-consuming lettering and unnecessary detail in most of the drawings we find today. As a matter of fact, too much detail simply makes the drawing more difficult to follow.

I have used Isometric pipe drawings for many years and I have never had any complaints from clients or from contractors. I believe they are much easier to follow than the conventional plan and elevation. Of course, there are times when one has to revert to the carefully prepared drawing of some detail.

There is not much given in your report, on the preparation of flow charts. I think many of our designers could make them a bit more legible if the starting point was clearly marked by a box or heavy arrow and then the end product brought to a line at the bottom of the flow chart. Many flow charts are very much like a man getting on a horse and riding off in ten different directions at once.

I think you did a service by publishing this report in your August issue.

Harold S. Bell
Consulting Engineer

Newark, N. J.

Field Training Needed

To The Editor:

I have read through your report "Six Steps to Better Drafting Practices."

All of the techniques illustrated have been used in our office during the last two years or so with varying degrees of success. Drafting costs have been cut in every case but it has been found that the pipe fitters in the field are not being trained to understand the newer types of drawings as fast as they are appearing and a reduction in engineering time does not always result in a total over-all cost reduction.

Whilst theoretically the drawings are just as clear as the more conventional double line drawings the interpretation by the field crews of the contractor's organization leaves something to be desired at times.

Draftsmen are not very receptive to the newer techniques as they feel that the quality of the work is deteriorating and the sense of craftsmanship which has taken years to build and achieve is being systematically undetermined.

Leslie Cox

Cleveland, Ohio

Economy and Ease

To The Editor:

I have read the Special Report on "Six Steps to Better Drafting Practices" with great interest. I approve of your aim completely. Simplicification without sacrifice of clarity is most desirable.

I am with Southern Pacific Pipe Lines Inc. I feel that many of the suggested procedures could profitably be applied to our work as well as to that of any other company engaged in similar work.

I was especially impressed with the economy and ease of visualizing in the isometric views of piping systems.

The suggestions on lettering are most logical and follow rather closely the practice of our company.

I do in general appreciate the report's attitude toward the artistic drawing. However, I can see special needs for such drawings where they might be helpful in presenting or selling projected ideas to laymen not conversant with engineering drafting practice.

It is gratifying to encounter the intelligent interest your report shows in the problem of improved drafting procedure for the pipe line industry.

Richard Sadlowski

Sierra Madre, Calif.

Good and Practical

To The Editor:

"Six Steps to Better Drafting Practices" is one of the better and more practical condensations of anything that has been written about "simplified drafting" in recent years. Your presentation is directly "functional" and is the reference that many of us in the consulting and construction areas prefer.

Your references to "isometric piping" are particularly good while your suggestions on "free hand sketching" are commendable.

"Drafting room tips" is also good and it's a broad enough area that it could be expanded into a short and separate article.

How soon will reprints be available on the whole article?

I sincerely appreciate the opportunity of contributing my comments.

E. S. Conrad
Catalytic Construction Co.

Philadelphia

Editor's Note—*Reprints are currently available at $1. per copy with discounts allowed for quantity purchases.*

More on Engineers

To The Editor:

Your "Look Box" for June, 1958 (page 121) discussing "The Case of an Engineer "Shortage", " points out that one third of new engineering graduates may be unable to step directly into industrial posts. Writers W. A. Cunningham and J. J. McKetta then call for reappraisal of efforts by Engineers Joint Council and similar organizations to recruit students into engineering schools.

A summary of some background material may help clear the picture.

The outcry of an engineering shortage arose primarily when studies of the country's expected industrial level 10 or 20 years from now showed that our schools were not producing the number of technical graduates needed to staff our plants at that time. The feeling of concern was reinforced when reports came back that the Russians were graduating larger numbers of engineers than ourselves, although their university population is relatively and absolutely smaller than ours.

At the same time, the cost of an engineering Bachelor's Degree here has been approaching the $20,000 mark. In our social climate, intellectual achievement is held in derision if not contempt. As a result of these cash and social factors, many of our most capable secondary school students have not been continuing to college and have been avoiding the scientific and engineering disciplines when they have gone on. Finally, the return has not justified the heavy investment in time, money, and hard work required of the engineering graduate. So the attrition rate among scientific graduates has been high; at least 40 percent have left for other pastures.

U. S. business conditions are always subject to fluctuations. To allow the current downturn to cut back already unsatisfactory training rates and pay rates might be dangerous to the long-term progress of the country.

A historical note: During the depression 30's, the federal government offered low cost loans to electric utility companies in order to develop the Tennessee Valley basin. The companies refused the responsibility. Today, the federal government's Tennessee Valley Authority operates a world-famous installation on the site.

Is a similar development in the scientific professions beyond the range of possibility?

Samuel Schiffer

Philadelphia, Pa.

Questions Prediction

To The Editor:

We noted with interest your article "Urea—the Petrochemical to Watch" in the August, 1958 issue of PETROLEUM REFINER. Being producers of urea we are naturally interested in the markets and future of urea and its many derivatives. We were surprised to see your prediction of 120 million pounds of urea going into a group of derivatives, headed by sulfamic acid, for 1958.

Most of these chemicals are produced by a limited number of companies, and are not included in the usual sources of production data. However, we are aware of an estimate made in the June 22, 1957 issue of "Chemical Week" which mentioned a figure of 20 million pounds of urea going to sulfamic acid. Other than this our information is very sketchy, but we generally felt this group of derivatives would not use more than about 40 million pounds of urea annually in the next few years. According to our information most of these derivatives are fairly low volume items (less than one million pounds a year) when made from urea. Sulfamic acid and its ammonium sulfamate salt are higher volume materials, probably followed by the barbiturates.

Since your figure appears to be about three times greater than our estimates we would appreciate receiving your comments on this subject.

H. L. Mahl
W. R. GRACE & COMPANY
Grace Chemical Division

Memphis, Tenn.

Author Comments

I appreciate your calling my attention to the error in estimating one of the uses of urea for 1958. The figure of 120 million pounds instead of referring to chemical uses only should have referred to all uses other than in fertilizers, animal feed and synthetic resins.

Lewis F. Hatch

Austin, Texas

Your Guide to the Best Process Combinations

If you are considering upgrading quality and reducing costs, how can you be sure *which* of the many processes on the following pages is best suited to your needs? What will be its *ultimate* cost, as well as initial investment? Can it be *economically and quickly* integrated with existing processes and equipment? Will it have the flexibility for *future* market requirements? Is it wise, in fact, to plan on modernizing by *degrees?* Or would it be more sound to scrap outmoded facilities, as have some leading refiners, and *rebuild completely?*

When the decision is to start from scratch, hundreds of combinations of variables are involved—in choosing location, type and range of crudes, product mix, process line up, degree of integration, refinery size. Which combination of these and other factors will insure the optimum in efficiency, yields, flexibility for the future, and return on investment?

The M. W. Kellogg Company, which has many of its processes described in the following pages—and has participated to one degree or another in practically all leading refining developments—is in a unique position to advise on *any* individual process or combination of processes. And, by virtue of its complete and coordinated contracting service, can undertake the entire responsibility for process and design engineering, procurement, and construction *within its own organization.*

Of particular benefit to Kellogg customers in the evaluation of processes and equipment is the addition to Kellogg's engineering facilities of the electronic computer. With this high speed aid, not only can Kellogg engineers devote more time to basic design problems, but the greater number of alternates economically possible assures the optimum process or combination of processes.

Kellogg's Process Engineering Division, together with its Refinery Plans and Economics Department, welcomes the opportunity to discuss your modernization and expansion programs.

The M. W. Kellogg Company, 711 Third Avenue, New York 17

A Subsidiary of Pullman Incorporated

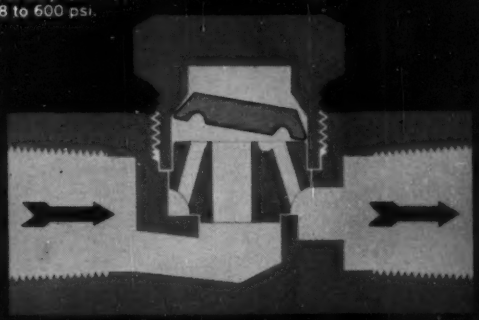
KELLOGG INTERNATIONAL CORPORATION, 7-10 CHANDOS ST., LONDON W.1., ENGLAND
SOCIETE KELLOGG, 28 RUE BAYARD, PARIS 8E, FRANCE
THE CANADIAN KELLOGG COMPANY, LIMITED, 33 BLOOR ST. EAST, TORONTO 5, CANADA
COMPANHIA KELLOGG BRASILEIRA, AVENIDA RIO BRANCO 57, RIO DE JANEIRO, BRAZIL
COMPANIA KELLOGG DE VENEZUELA, CARACAS, VENEZUELA
KELLOGG PAN AMERICAN CORPORATION, 711 THIRD AVENUE, NEW YORK 17, N. Y.

M KELLOGG W

NEW YARWAY IMPULSE* STEAM TRAP ENGINEERED FOR YOUR LIGHT LOAD REQUIREMENTS

YARWAY NO. 30

Actual size new Yarway No. 30 (½" size). For all pressures 8 to 600 psi.



Cross-section Yarway No. 30 shows lever valve in open position.

- **Economy of operation on light loads**
  - **Closer shut-off**
  - **Quieter operation due to lever action**
- **Economy of Maintenance**
  - **Replaceable valve-seat assembly**
  - **One moving part**
  - **Stainless steel construction**

Put this trap on tracer lines, steam line drips and other light load applications. Order from your local Yarway distributor.

For free bulletin, write Yarnall-Waring Company, 100 Mermaid Ave., Philadelphia 18, Pa.

*IMPULSE . . . A COMPLETE LINE OF STEAM TRAPS, OPERATING ON A PROVEN THERMODYNAMIC PRINCIPLE.

YARWAY *impulse*®

OVER 1,250,000 ALREADY SOLD

USE THESE YARWAY IMPULSE TRAPS FOR ALL OTHER STEAM TRAP NEEDS

NORMAL NEEDS Famous Series 60 Impulse traps (pressures to 400 psi) and Series 120 (pressures to 600 psi) meet most normal needs

EXTRA HEAVY CONDENSATE LOADS Series 40 Impulse traps have extra large capacity to handle large volumes of condensate

POWER PLANT AND MARINE SERVICE Yarway Integral Strainer Traps fill the bill for marine and high pressure power plant jobs

THEY HELPED PLAN THIS ISSUE. A conference established the limits and type of material included in the 1958 Process Handbook. Attending were the industrial experts shown, left to right: W. E. Askey, The Pace Company, Houston; C. E. Bochow, Suntide Refining Company, Corpus Christi, Texas; Lewis Gross, Delhi-Taylor Oil Corporation, Corpus Christi; R. E. Dugat, Humble Oil & Refining Company, Baytown, Texas; and Oswald Newell, Jr., Continental Oil Company, Houston, (not shown).*

1958 PROCESS HANDBOOK

THIS NEW EDITION of the Process Handbook now brings you the most complete and up-to-date assembly of refining processes of importance to the modern refiner. It includes all of the new processes introduced to the industry during the two years since the 1956 edition. The Handbook also contains new data for some of those older processes.

To assure authoritative information, the process descriptions are presented by companies active in the field. You should remember, however, that the contributor of the unlicensed processes may not be the only one qualified to design and construct the process for your refinery.

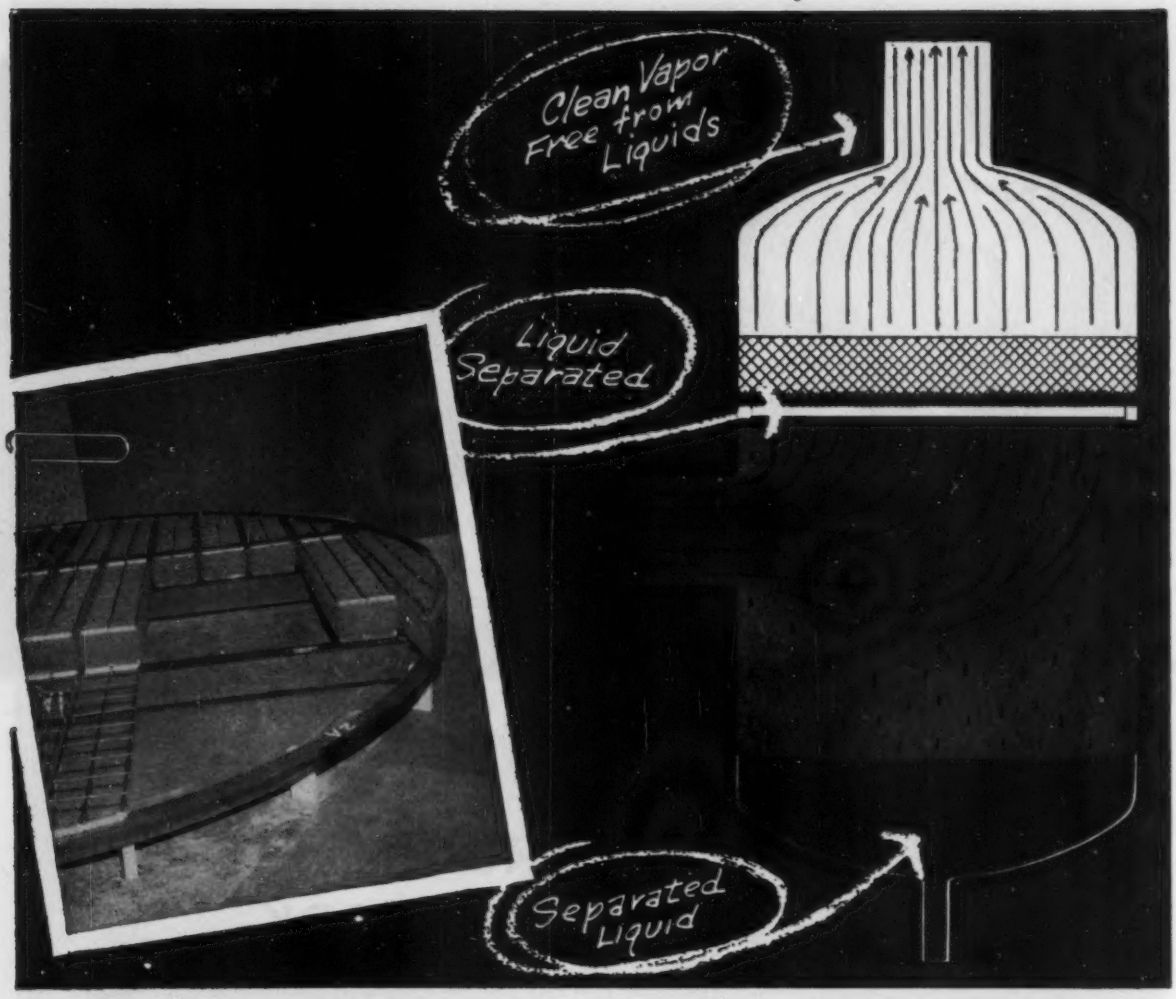
All of the refining processes are here—classified and summarized into broad processing categories for easy reference. The descriptions reflect the greater emphasis given economic data on installation and operation costs. And if you need more detailed information, literature references accompany most of them to tell you where to look.

For a bonus, we include a special report on alkylation. This special report tells all about the process which is fast gaining prominence as a source of material for better motor fuel blending. Thus, the 1958 Process Handbook will make a valuable addition to your reference files.

Harold L. Hoffman

PROCESS AND CONSTRUCTION EDITOR

* The attendance by executives, engineers, superintendents, and other employes of oil and petrochemical companies at these conferences does not constitute an endorsement of Petroleum Refiner over any other one publication. The fact that men of outstanding ability are allowed to attend these planning conferences shows the interest which the oil and petrochemical industry has in sound editorial content planned for the benefit of the industry and those who work in it.



How to IMPROVE Process Vessel PERFORMANCE

By effecting clean separation of liquid from vapor Yorkmesh Demisters improve process vessel performance.

In **distillation equipment** liquid entrainment is controlled, giving better quality overhead products even at increased thruput rates.

In refinery **vacuum towers,** higher quality gas oil means higher conversion rates to gasoline in the cat cracker.

In **absorbers,** loss of absorbing liquid is prevented.

In **separator vessels** and **knock-out drums** greater liquid recovery results.

In compressor **suction drums,** complete liquid separation decreases compressor maintenance.

In **evaporators,** by controlling liquid carry-over product loss is avoided, and high purity condensate is suitable for boiler feedwater or process use.

In **steam drums** the result is clean, dry steam.

In **vent stacks** Yorkmesh Demisters contribute to the solution of air pollution problems.

Write for Bulletin 17 and a complete list of the many case histories available from our technical library.

YORK

OTTO H. YORK COMPANY, INC.
6 Central Avenue, West Orange, N. J.

Specialists in FLUIDS SEPARATION / ENGINEERS and MANUFACTURERS

Process Groups

	Page
REFORMING (Fixed Bed)	215
Catforming	217
Cycloversion	218
Houdriforming	219
Iso-Plus Houdriforming	224
Platforming	220
Powerforming	221
Rexforming	226
SBK Catalytic	222
Ultraforming	223
REFORMING (Others)	215
Fluid Hydroforming	228
Thermal	230
CRACKING	231
Airlift TCC	232
Coking, Delayed	244
Coking, Fluid	246
Coking, Low Pressure	244
Combination Cracking	248
Combination Unit	249
Decarbonizing	244
Fluid Catalytic	234
Fluid Catalytic, Model IV	236
Fluid Catalytic, Orthoflow	238
Fluid Catalytic, Two Stage	240
Houdresid	242
Houdriflow	242
H-Oil	247
Thermal	250
Visbreaking (Combination)	249
ALKYLATION	251
Aluminum Chloride	253
Cascade Sulfuric Acid	254
Effluent Refrigeration	255
HF	256
HF, Perco	257
ISOMERIZATION	251
Butamer	258
Butane Vapor-Phase	259
Catalytic	260
Iso-Kel	261
Isomate	262
Isomerate	263
Liquid-Phase	264
Penex	265
Pentafining	266
POLYMERIZATION	252
Bulk Acid	267
California	268
Polyco Catalytic	269
Solid Phosphoric Acid Condensation	270
SOLVENT REFINING	271
Duo-Sol	272
Furfural Extraction of Gas Oils	273
Furfural Refining	274
Phenol Extraction	275
Propane Deasphalting and Fractionation	276
Propane Dewaxing and Deoiling	277
SO_2 Extraction	278
Solvent Decarbonizing	279
Solvent Dewaxing	280
Wax Fractionation	281
TREATING (With Hydrogen)	271
Autofining	282
Diesulforming	283
Gulf HDS	284
Hydrodesulfurization	285
Hydrofining	286
Trickle Hydrodesulfurization	287
Ultrafining	288
Unifining	289
Vapor-Phase Hydrodesulfurization	290
TREATING (Others)	271
Bender	291
Chemical Desalting	292
Continuous Contact Filtration	293
Copper Sweetening	294
Distillate	295
Doctor Sweetening	296
Dualayer Distillate Process	297
Dualayer Gasoline Process	298
Electric Desalting (Petreco)	299
Electrical Desalting (Howe-Baker)	300
Electrical Distillate	301
Electrolytic Mercaptan	302
Girbotol	303
Glycol Amine Gas	304
Mercapsol	305
Percolation Filtration	306
Phosphate Desulfurization	307
Solutizer Process	308
Unisol Mercaptan Extraction	309
OTHER REFINING PROCESSES	271
Butane Dehydrogenation	310
Crude Distillation (Combination)	249
Crude Distillation for Maximum Cracking Feed	311
Crude Distillation for Maximum Lubes	312
Grease Manufacturing	313
Light Hydrocarbon Recovery	314
Vacuum Flashing (Combination)	249

Contributors

	Page
AMERICAN DEVELOPMENT COMPANY	
Electrolytic Mercaptan	302
ATLANTIC REFFINING COMPANY	
Catforming	217
Pentafining	266
THE BRITISH PETROLEUM COMPANY, LTD.	
Autofining	282
CALIFORNIA RESEARCH CORPORATION	
Bulk Acid Polymerization	267
California Polymerization	268
ESSO RESEARCH & ENGINEERING COMPANY	
Fluid Catalytic Cracking, Model IV	236
Fluid Coking	246
Fluid Hydroforming	228
Hydrofining	286
Powerforming	221

(Continued on Page 213)

When you need

BASIC CHEMICALS FOR PETROLEUM

look to General Chemical!

Here's why...

General Chemical is the leading supplier of a great many basic chemicals used in petroleum production and processing. Its nationwide chain of plants and warehouses, large-scale production, extensive research and technical service—all assure you of really dependable products and service. Call on us for these key chemicals:

ALKYLATION
Anhydrous Hydrofluoric Acid
Sulfuric Acid

POLYMERIZATION
Fluosulfonic Acid $HO{:}SO_2F$
Boron Trifluoride
Sulfuric Acid

SULFONATION
Sulfuric Acid
Sulfan® (Stabilized Sulfuric Anhydride)
Oleum

ISOMERIZATION
Hydrochloric (Muriatic) Acid

DETERGENTS, CLEANERS & BUILDERS
Sodium Metasilicate
Disodium Phosphate
Sodium Sulfate, Anhydrous
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

ACIDIZING
Hydrochloric (Muriatic) Acid
Hydrofluoric Acid
Sodium Bifluoride

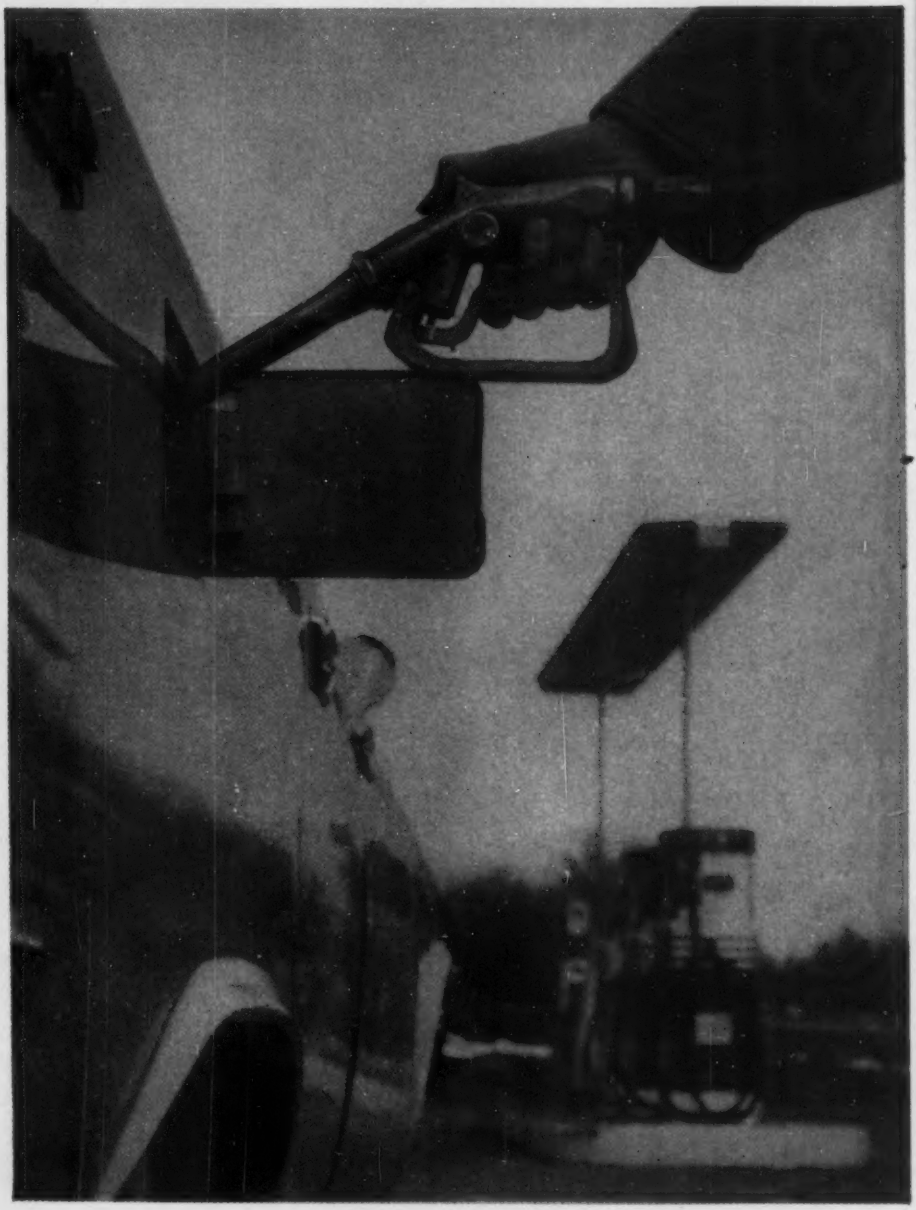
MUD CONDITIONING
Sodium Silicate
Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
Sodium Tripolyphosphate

GREASE MAKING
Aluminum Sulfate

ACID TREATING
Sulfuric Acid
Sodium Silicate

Other Heavy Chemicals, catalysts, addition agents, inhibitors and special "tailor-made" chemicals.

Baker & Adamson® Laboratory Reagents



Basic Chemicals
for American Industry

Allied Chemical

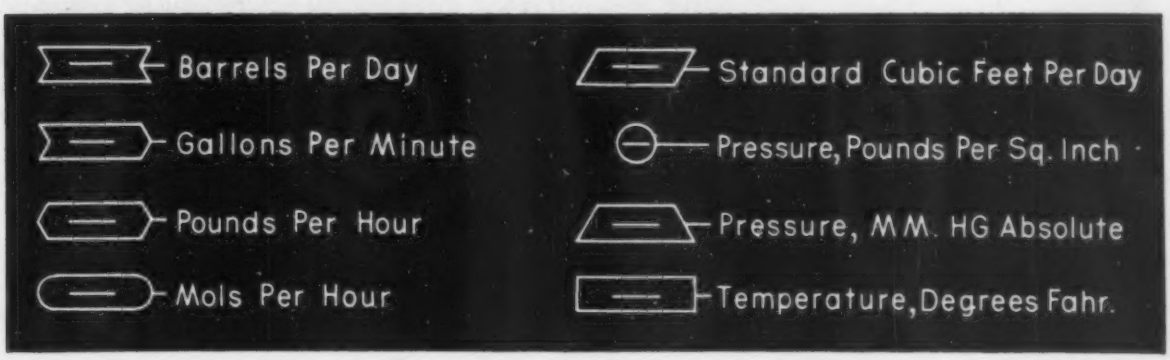
GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

(Contributors . . . Continued from Page 211)

	Page
FILTROL CORPORATION	
Continuous Contact Filtration	293
THE FLUOR CORPORATION, LIMITED	
Glycol Amine Gas Treating	304
FOSTER WHEELER CORPORATION	
Combination Unit	249
Crude Distillation for Maximum Lubes	312
GIRDLER CONSTRUCTION DIVISION OF CHEMETRON CORP.	
Girbotol	303
GULF RESEARCH & DEVELOPMENT COMPANY	
Gulf HDS	284
HOUDRY PROCESS CORPORATION	
Butane Dehydorgenation	310
Houdresid	242
Houdriflow	242
Houdriforming	219
Iso-Plus Houdriforming	224
HOWE-BAKER ENGINEERS, INC.	
Electrical Desalting	300
Electrical Distillate Treating	301
HUSKY OIL COMPANY	
Diesulforming	283
HYDROCARBON RESEARCH, INC.	
H-Oil	247
California Polymerization	267
THE M. W. KELLOGG COMPANY	
Cascade Sulfuric Acid Alkylation	254
Fluid Catalytic Cracking, Orthoflow	238
Hydrodesulfurization	285
Iso-Kel	261
Phenol Extraction	275
Polyco Catalytic Polymerization	269
Propane Deasphalting and Fractionation	276
Propane Dewaxing and Deoiling	277
SBK Catalytic Reforming	222
Solvent Decarbonizing	279
LINDE COMPANY, DIV. OF UNION CARBIDE CORP.	
Copper Sweetening	294
THE LUMMUS COMPANY	
Combination Cracking	248
Doctor Sweetening	296
MAGNOLIA PETROLEUM COMPANY	
Dualayer Distillate Process	297
Dualayer Gasoline Process	298
THE MILWHITE COMPANY, INC.	
Duo-Sol	272
MINERALS & CHEMICALS CORPORATION OF AMERICA	
Percolation Filtration	306

	Page
PETRECO DIVISION, PETROLITE CORPORATION	
Bender	291
Distillate Treating	295
Electric Desalting	299
PHILLIPS PETROLEUM COMPANY	
Aluminum Chloride Alkylation	253
Catalytic Isomerization	260
Cycloversion	218
HF Alkylation, Perco	257
THE PURE OIL COMPANY	
Isomerate	263
Mercapsol	305
SHELL DEVELOPMENT COMPANY	
Butane Vapor-Phase Isomerization	259
Fluid Catalytic Cracking, Two Stage	240
Liquid-Phase Isomerization	264
Phosphate Desulfurization	307
Solutizer Process	308
Trickle Hydrodesulfurization	287
Vapor-Phase Hydrodesulfurization	290
SOCONY MOBIL OIL COMPANY, INC.	
Airlift TCC	232
STANDARD OIL COMPANY (Indiana)	
Isomate	262
Ultrafining	288
Ultraforming	223
STONE & WEBSTER ENGINEERING CORPORATION	
Crude Distillation for Maximum Cracking Feed	311
SO_2 Extraction	278
STRATFORD ENGINEERING CORPORATION	
Effluent Refrigeration Alkylation	255
Grease Manufacturing	313
TEXACO DEVELOPMENT CORPORATION	
Furfural Extraction of Gas Oils	273
Furfural Refining	274
Solvent Dewaxing	280
Wax Fractionation	281
UNION OIL COMPANY OF CALIFORNIA	
Unifining	289
UNIVERSAL OIL PRODUCTS COMPANY	
Butamer	258
Fluid Catalytic Cracking	234
HF Alkylation	256
Penex	265
Platforming	220
Rexforming	226
Solid Phosphoric Acid Condensation	270
Thermal Cracking	250
Thermal Reforming	230
Unifining	289
Unisol Mercaptan Extraction	309

Flow Diagram Symbols Used In This Issue . . .



here's how to specify

DEKORON INSTRUMENT HARNESS

to fit your requirements exactly

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + plastic sheath = FOR CORROSION RESISTANCE

DEKORON METL-COR / DEKORON POLY-COR + steel armor = FOR IMPACT AND CORROSION RESISTANCE

ARMORED METL-COR / ARMORED POLY-COR + plastic sheath = FOR IMPACT AND MAXIMUM CORROSION RESISTANCE

ALUMINUM OR COPPER / POLYETHYLENE OR NYLON + insulating tape + steel armor = FOR IMPACT RESISTANCE IN DRY LOCATIONS

ARMORED TUBES + plastic sheath = FOR CORROSION AND IMPACT RESISTANCE

No matter what your special environmental requirements for instrument tubing may be—no matter how stringent for corrosion, impact or fire resistance—there's a type of Dekoron instrument line harness to *satisfy them exactly*. In most cases you can get *delivery from stock*. And *all* Dekoron products have three things in common: Highest quality materials and construction . . . lowest possible installation cost . . . longest life of any instrument line harness. That's *Dekoron—America's Premier Instrument Tubing Line.* AA-9864

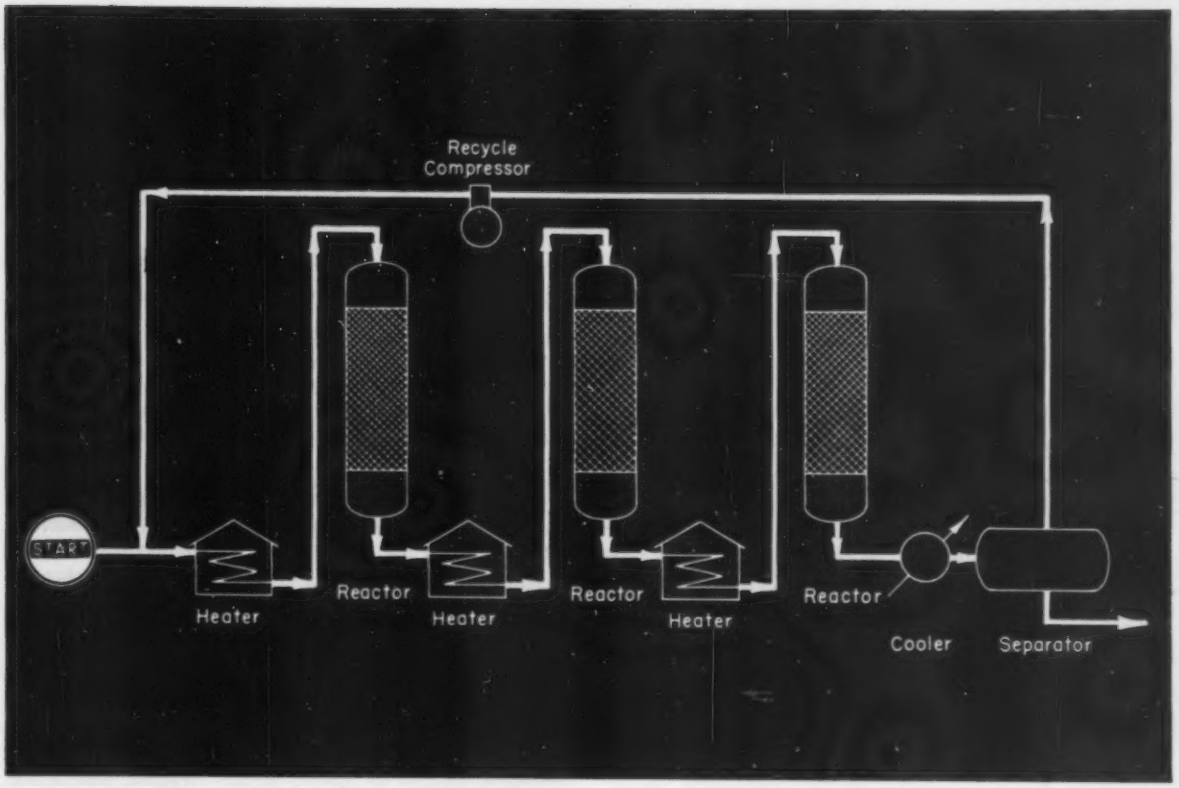
Dekoron® products

See us at Booth 1670, ISA Show
Philadelphia, September 15-19

SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

QUALITY • RESEARCH • SERVICE



Reforming

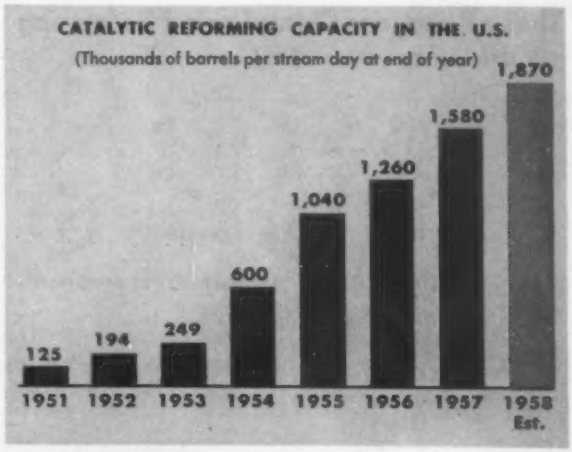
REFORMING is now the primary process for the production of motor fuel. This role, once held by catalytic cracking, has changed hands recently because of the continuing demand for higher octane blending components; a quality demand too high to be satisfied essentially by catalytically cracked stocks.

Reforming rearranges or reforms the components of naphtha into materials having higher octane ratings—primarily aromatics. When the reformed product is purified, it can find its way into petrochemicals. However, by far the greatest use of the reforming process is to produce aromatics for motor fuel blending.

The present capacity of catalytic reforming in the U.S. is 1,844,000 barrels of charge per stream day. This capacity is equivalent to 19 percent of our total crude running capacity. The tremendous growth of the reforming process can be seen when this present reforming capacity percentage of crude running is compared with the 13 percent of two years ago.

A record of the growth of catalytic reforming in the U. S. is shown in the accompanying bar graph. It is estimated enough new reforming units will be completed before the end of the year to push the total capacity to 1,870,000 barrels of charge per stream day.

The flow diagram of a typical fixed-bed catalytic reformer is shown above. The predominant reaction is the conversion of naphthenes into aromatics. If the reaction is carried out isothermally, the best relation of product yield to product octane is achieved. Since the reaction itself is endothermic, an outside source of heat is re-



Compare Catalytic Reforming Processes

PROCESS	CATALYST				OPERATING CONDITIONS		First U.S. Unit On-stream
	Composition	Form	Bed Type	Regeneration	Temp. °F.	Press., psig	
Cycloversion[1]	Bauxite	pellets	fixed	cyclic	950–1000	50–57	April, 1940
Fixed-Bed Hydroforming	MoO_3/Al_2O_3	pellets	fixed	cyclic	1000	150	Nov., 1940
Platforming	Pt/Al_2O_3	pellets	fixed	none	900	750	Oct., 1949
Catforming	$Pt/SiO_2/Al_2O_3$	pellets	fixed	occasional	850–1000	300–700	Aug., 1952
Fluid Hydroforming	MoO_3/Al_2O_3	powder	fluid	separate	890–940	200	Dec., 1952
Houdriforming	Pt/...	pellets	fixed	occasional	950	300	Nov., 1953
Ultraforming	Pt/Al_2O_3	pellets	fixed	cyclic	900–950	200–500	May, 1954
Sinclair-Baker-Kellogg	Pt/Al_2O_3	pellets	fixed	cyclic	825–950	200–500	Sept., 1954
Sovaforming	Pt/	pellets	fixed	occasional	.....	.....	Nov., 1954
Thermofor Catalytic	Cr_2O_3/Al_2O_3	beads	moving	separate	950–1000	100–200	Mar., 1955
Orthoforming	MoO_3/Al_2O_3	powder	fluid	separate	.....	.....	April, 1955
Hyperforming	Cobalt Moly	pellets	moving	separate	870	400	May, 1955
Powerforming	Pt/...	pellets	fixed	cyclic	.....	.....	July, 1955
Rexforming	See Platforming	.....	.....	.....	.....	.....	April, 1956
Iso-Plus	See Houdriforming	.....	.....	.....	.....	.....	April, 1957

[1] First units used for desulfurization.

quired to get the charge to process temperature and hold it there.

The dehydrogenation of the charge in reforming produces a hydrogen-rich stream. Some of the hydrogen is recycled to suppress coke formation, to sustain reactor pressure, and to furnish the requirements for any side reactions of hydro-cracking which may occur. More hydrogen is produced, however, than is needed to fulfill the process requirements. Therefore, reforming is a ready source of hydrogen for other refining processes such as hydrodesulfurization.

For a comparison of the catalytic reforming processes which have been considered by the industry, examine the accompanying table. This table shows the type of catalysts, the operating conditions, and the time when the first unit was put on stream in the U.S.

Thermal reforming was the first method practiced for the upgrading of gasoline materials, being introduced shortly after 1930. The thermal process usually is accompanied with a production of gaseous materials so that polymerization is needed in order to give a good over-all yield of gasoline.

Catalytic reforming for gasoline upgrading was not put into operation until November, 1940. The principle of catalytic reforming was practiced earlier, but it was of a milder nature for the desulfurization of a stock. The next reforming process was not introduced until early in 1949. Even by the end of 1951, reforming furnished only a little over 100,000 daily barrels, and most of this was spurred into existence by the demand for toluene during World War II.

The first announcements of catalytic reforming were followed by many more until now there are 15 processes devised for reforming naphthas and gasolines for octanes. Some of these applied the fluidized catalyst technique to their operation. Others combined aromatic separation and raffinate recycle to achieve higher aromatic production.

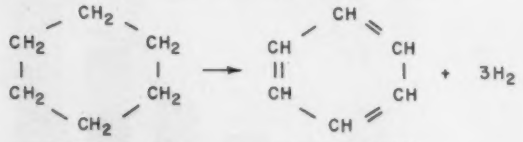
Some typical reactions are shown below to exemplify what happens during reforming. The numbers in parenthese are the octanes of the compounds at 3 cc TEL per gallon.

The dehydrogenation of naphthenes is the predominant reaction. The isomerization of naphthenes and paraffines is next followed by dehydrocyclization and hydrocracking.

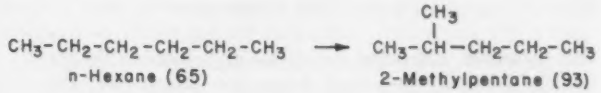
A review of catalytic reforming is included in the comprehensive article by Marshall Sittig on "How to Get Those Top Octanes," PETROLEUM REFINER, vol 34, no 9, pp 230-280 (Sept, 1955).

These Reactions Occur During Reforming

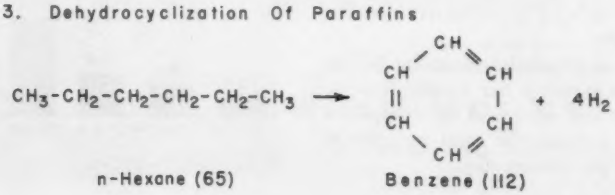
1. Dehydrogenation Of Naphthenes



2. Isomerization Of Paraffins



3. Dehydrocyclization Of Paraffins



Catforming—THE ATLANTIC REFINING COMPANY

Application: To convert low-octane naphthas to finished high-octane gasoline and to produce aromatics for petrochemicals or aviation gasoline. The catalyst promotes the following chemical reactions: Conversion of naphthenes to aromatics, aromatization of paraffins, isomerization of paraffins, hydrocracking of high-boiling paraffins and desulfurization by conversion to hydrogen sulfide.

Charge: Any straight run naphtha fraction of either wide or close-cut boiling range. Hydrogenated cracked naphthas or selected cuts for aromatic production may also be charged. A dry charge stock is not necessary.

Product: For motor gasoline operation, the reactor product requires only stabilization before inclusion in finished gasoline. No rerunning, sweetening or other finishing treatment is required.

Description: Atlantic Catforming is a selective catalytic reforming process employing a platinum on silica-alumina catalyst. Naphtha may be charged to the reaction section without use of feed preparation; however, for high-severity operations hydrogen pre-treating is recommended. The feed is joined with a hydrogen-rich recycle gas stream and preheated by exchange with effluent from the last reactor. The mixture is then heated to reaction temperature in a furnace and passed through fixed-bed reactors in series. Reheaters between the reactors are used to compensate for the heat consumed in aromatics formation. The effluent from the final reactor, after exchange with the feed, is condensed in a cooler and separated from the hydrogen recycle and make gas in a high-pressure flash. The recycle hydrogen is compressed and returned to the reactors, while net hydrogen production is vented from the unit under pressure control. Having a high hydrogen content, the make gas may be used in hydrogenation or in petrochemical processing. Liquid from the flash drum flows to a conventional stabilizer.

In Catforming high-sulfur stocks at low or moderate severity, desulfurization may be accomplished by conventional scrubbing of the recycle gas in an amine absorber. Since neither nitrogen nor water is a catalyst poison, water washing or glycol scrubbing of the absorber effluent gas is not required. As noted, before high-severity operations make desulfurization by hydrogen pre-treating an economic method.

Carbon is deposited very gradually on the catalyst during normal operation. After a long run, the catalyst may be restored in activity by burning the carbon deposit in a combustion stream of low oxygen content. The ability to regenerate simply and quickly also saves considerable catalyst life if a major upset lays down a heavy carbon deposit.

Operating Conditions: Reaction temperature varies from 850 F. to 1,000 F. while pressure is maintained at 300-700 psig. Product yields and qualities depend heavily on feed properties and operating severity.

Yields: Typical yields and qualities for a variety of feed stocks are shown in the accompanying table. It should be noted that Catforming catalyst tends to hydrocrack at or near the middle of a chain thus producing C_3-C_4 fragments rather than C_1-C_2 fragments. Yields of C_3+ or C_4+ products are very high.

Commercial Installations: Twenty-seven Atlantic Catformers are either operating or under construction. Capacities range from 500 to 15,000 bpd. Of these, 10 operate with hydrogen pre-treatment of the charge stock.

Reference: PETROLEUM REFINER, vol 36, no 4, p 146 (Apr, 1957).

	East Texas		Arabian		California		Kuwait	
Charge:								
ASTM Distill, °F—10 Percent	236		268		295		288	
50 Percent	268		294		309		300	
90 Percent	317		334		338		320	
Sulfur, Wt.%	0.0005		0.03		0.028		0.04	
F—1 Octane, Clear	51.5		37.4		60.2		31.9	
Yield:								
Debut. Gaso., Vol.%	87.3	83.8	83.7	79.4	92.2	90.3	82.6	78.3
C_4 Vol. %	6.4	6.8	11.8	14.3	3.1	4.3	12.4	14.9
C_3 Wt. %	2.9	4.0	5.0	6.6	1.8	2.3	5.3	7.0
C_2 Wt. %	0.8	1.1	1.1	1.4	0.5	0.7	1.3	1.6
C_1 Wt. %	0.4	0.6	0.6	0.7	0.3	0.3	0.7	0.8
H_2 Wt. %	1.7	1.7	0.4	0.4	1.5	1.7	0.4	0.5
Debutanized Gaso:								
RVP, psi	2.8	3.5	4.6	5.7	2.1	2.4	5.0	6.0
ASTM Distill, °F—10%	201	191	176	162	212	207	171	158
50%	260	256	279	275	307	305	285	280
90%	330	333	344	346	350	353	332	335
F-1 Octane @ 10 psi RVP:								
Clear	90.5	95.0	90.3	95.0	90.5	95.0	90.2	95.0
+ 3 cc TEL	98.6	100.6	98.5	100.7	97.9	100.0	98.4	101.0

Cycloversion— PHILLIPS PETROLEUM COMPANY

Application: Used (1) to desulfurize straight run and cracked gasolines, naphtha fractions and kerosines, (2) to reform straight run gasoline or naphtha in order to upgrade octane numbers and to improve lead susceptibility, (3) to catalytically crack gas oil stocks for the production of high octane gasoline. Desulfurization is particularly applicable in preparation of feed stocks for catalytic reforming operations.

Charge: Under desulfurization conditions the charge stocks can be either a full boiling range gasoline or a naphtha fraction. Various mixtures of cracked and straight run charge stocks can be processed in a combined operation. Under reforming conditions the charge stocks are similar to those processed to effect desulfurization. Gas oil cracking charge stocks having a boiling range 400-800 F. can be satisfactorily processed.

Product: Catalytic desulfurization of the straight run or natural gasoline charge stocks results in no appreciable change in the composition of the treated product other than the reduction of sulfur content. With cracked gasoline the octane improvement is due to desulfurization and some isomerization. The absence of undersirable side reactions is indicated by the fact that there is no appreciable change in physical properties such as vapor pressure, gravity or distillation characteristics.

Benefits gained by catalytic reforming include those obtained from catalytic desulfurization together with an appreciable increase in clear and leaded octane ratings.

Catalytic gas oil cracking yields highly olefinic gases, high octane motor fuel, low pour point recycle stocks and bottoms.

Description: Cycloversion is a fixed-bed catalytic reforming process. The heater and heat exchangers are of conventional design and serve to heat the feed stock to the desired temperature with a minimum of thermal decomposition. Two reactors are provided for continuous operation, i.e., one chamber is on process while the other is being regenerated. The rerun and stabilization facilities are also conventional in design. The steam superheater and air compressor are regeneration facilities which are used for reactivating the catalyst in situ. An installation of this type can be used for any of the applications of Cycloversion. However, rerun and stabilization facilities are not required for straight run desulfurization. Also, some units built for desulfurization service, have only a single reactor and do not include regeneration facilities. These installations discard the catalyst when it is spent and recharge the reactor with new catalyst.

The higher carbon deposition on the catalyst for gas oil cracking and reforming operations precludes the use of the non-regenerative unit. Process cycles vary from three to 12 hours when processing gas oil and from 12 to 72 when reforming. Steam is added with the gas oil charge to suppress carbon deposition on the catalyst but is not generally used in the desulfurization or reforming operation.

Caustic washing facilities are generally provided to remove the H_2S formed when the sulfur compounds are decomposed. No further treatment is usually necessary.

The catalyst is cyclocel grade bauxite and is a natural occurring material. It has a life of 5000-20,000 barrels per ton when used in non-regenerative desulfurization units and 50,000-100,000 barrels per ton when used in regenerative units.

Operating Condition: The major process variables are temperature, pressure, and space velocity. High temperatures increase the depth of conversion. Lower pressures increase the olefinicity of the gasoline obtained from gas oil cracking which in turn increases the octane rating of the product. Increasing space velocity at constant temperature and pressure decreases the depth of conversion.

Yields: In the desulfurization operations, the yields are 98.0-99.5 liquid volume percent of charge. Yields from reforming are dependent on the severity of the operation. This is also true for gas oil cracking though in this operation a 50 percent conversion is considered normal. Typical data for the three types of operation which can be performed in the Cycloversion process are shown in the tables below.

Commercial Installations: The first Cycloversion unit was installed in 1940. At present there are 32 units in operation with a total designed thruput of over 100,000 barrels per day. These units range in size from 300-20,000 barrels daily.

TABLE 1
Cycloversion of Mid-Continent Gas Oil

Feed Stock:		
Gravity, °API	32.2	....
10 Percent (Vacuum)	604	....
90 Percent (Vacuum)	752	....
Aniline Point, °F	181	....
Catalytic Gasoline, C_5—400° F	Test 1	Test 2
Gravity, API°	55.1	54.9
Reid Vapor Pressure	6.0	6.6
F-2 Octane Number	80.4	81.1
+3 cc. TEL	84.5	84.7
F-1 Octane Number	94.3	94.5
+3 cc. TEL	97.8	98.0
Yields, Percent of Charge:		
Cat. Gasoline, C_5-400° F., Vol. Percent	28.6	33.2
10 Lb. RVP., Gasoline, Vol. Percent	37.4	42.9
Propylene, Vol. Percent	4.1	4.2
Butylenes, Vol. Percent	4.9	5.6
Cat. Recycle 400° F., + Vol. Percent	59.1	50.7
Carbon, Weight Percent	1.5	2.3
Conversion, Single Pass Vol. Percent	40.9	49.3

* Butanized and includes potential catalytic poly gasoline.

TABLE 2—Reforming

Sample Designation		Debutanized Reformed Naphtha	
Test Number	Charge	One	Two
Operating Conditions:			
Space Velocity, V/V/Hr.	....	1.0	1.0
Cat. Chamber Inlet, °F	....	875	974
Cat. Chamber Pres., Psig.	....	50	50
Yield Summary:			
Debut. Ref. Naph., Vol. Percent Charge	....	95.6	88.7
F-1 Octane Ratings:			
Clear	42.7	52.2	68.0
Plus 1.0 cc. TEL/Gal.	51.0	62.3	75.4
Plus 3.0 cc. TEL/Gal.	59.4	73.3	83.3
API Gravity @ 60 F	46.9	46.3	46.1
R.V.P. psi	1.5	1.1	3.2
Total Sulfur, Weight Percent	0.184	0.011	0.020
ASTM Dist. °F.:			
IBP	271	187	129
10 Percent	312	297	259
30 Percent	324	320	309
50 Percent	334	333	327
70 Percent	346	348	344
90 Percent	365	370	367
End Point	416	429	442

TABLE 3—Desulfurization

	Straight-Run Gasoline	
	Charge	Product
Operating Conditions:		
Space Velocity, V/V/Hr.	....	1.0
Cat. Chamber Inlet, °F.	....	803
Cat. Chamber Pres., Psig.	....	50
F-1 Octane Ratings:		
Clear	64.2	66.3
Plus 1.0 cc. TEL/Gal.	71.5	76.6
Plus 3.0 cc. TEL/Gal.	78.1	85.5
Yield Summary:		
Yield, Vol. Percent Charge	....	99.6
API Gravity @ 60° F.	64.6	63.9
R.V.P. psi	11.1	10.7
Total Sulfur, Weight Percent	0.123	0.004
Mercaptan Sulfur, Weight Percent	0.049	0.001
Doctor Test	Sour	Sweet
ASTM Dist. °F.:		
IBP	94	96
10 Percent	117	131
30 Percent	171	176
50 Percent	207	203
70 Percent	239	239
90 Percent	281	278
End Point	339	343

Houdriforming—HOUDRY PROCESS CORPORATION

Application: (Houdriforming) To reform straight run and cracked naphthas using a platinum-containing catalyst.

Charge: A wide variety of feedstocks, differing substantially in chemical composition and having end boiling points up to 400 F. Low-octane naphthas may be upgraded efficiently to obtain very high octane level components required for blending in present-day motor fuels.

Products: Aviation blending stocks, aromatics, and motor gasoline in the 80-100 F-1 clear octane range, depending upon feed composition and type or severity of operating conditions. Stabilized Houdriformate requires no further treatment.

Description: Houdriforming catalyst used in the process meets exacting specifications for activity, selectivity and strength. It is well balanced to carry out the dehydrogenation, aromatization, isomerization, hydrocracking and desulfurization reactions involved.

Pre-treatment of high-sulfur stocks is provided by means of a catalytic pretreat chamber with its own preheater. This "guard case" is constructed as an integral stage of the Houdriforming operation when required for the feed stock.

At moderate severities, Houdriforming may be operated continuously for either high octane motor gasoline or aromatics, without provision for catalyst regeneration. The process also provides refineries with hydrogen of high purity for use in other refinery processes.

If high severity operation is required, Houdriforming lends itself readily to in-place catalyst regeneration, as has been demonstrated commercially.

When operated for aromatics, Houdriforming converts the appropriate naphthenes to benzene, toluene and xylenes at yields approaching 100 percent of theoretical values, with significant aromatization of parraffins.

Commercial Installations: Total licensed Houdriforming capacity amounts to 179,990 bpsd. Worldwide, 22 units are now on stream or under construction. The largest catalytic reforming unit in the world is a twin-train Houdriformer with total daily design capacity of 45,000 barrels.

Reference: PETROLEUM REFINER, Vol. 32, No. 5, p 113 (May, 1953).

Operating Conditions: Temperature 875-980°F.; Pressure 250-600 psig; Space velocity 1.5-5.0 v/hr/v; Hydrogen-oil mole ratio 4-10.

HOUDRIFORMING FOR MOTOR GASOLINE

Debutanized Reformate, Volume Percent	F-1 Octane With 3cc TEL
94.4	90.2
92.1	93.9
88.7	96.9
86.8	98.3

Reformate Inspection	Naphtha Charge	Reformate
Gravity, °API	52.6	47.7
Distillation, °F. Ibp	198	114
10	222	188
30	242	228
50	264	256
90	340	340
D.P.	376	414
F-1 Octane Clear	54.6	89.5
F-1 Octane + 3cc TEL	76.2	98.5
Composition (Depentanized Bases)		
Paraffins	42.7	39.1
Olefins	0.7	1.1
Naphthenes	37.8	3.4
Aromatics	18.8	56.4

HOUDRIFORMING FOR AROMATICS

Type of Operation	Benzene-Toluene	Xylene
Charge Composition, Volume Percent		
Paraffin	49	52
Naphthenes	44	40
Aromatics	7	8
Plant Charge Rate, BPD	12,500	10,000
Plant Yields		
Stabilized Product, Volume Percent	90.8	87.0
High Pressure Gas, SCF/Bbl.	1120	1140
Product Composition, Volume Percent		
Paraffin	53	52
Olefins	0	0
Naphthenes	4	0
Aromatics	43	48
Hydrogen Purity of High Pressure Gas	97	95.5
Plant Performance		
Net Aromatics Yield Vol. Percent of Charge	32.0	33.8
Net Aromatics Percent of Theoretical	87	101

Note: These yields were established by surveys of plant performance after five months catalyst life.

Platforming—UNIVERSAL OIL PRODUCTS COMPANY

Application: (1) To upgrade low-octane naphthas to premium quality motor fuels, (2) to produce high yields of aromatic hydrocarbons from select naphtha cuts, and (3) to produce high-quality aviation gasoline components.

Charge: For motor fuel operation; straight run and/or cracked naphthas boiling in the range of 150-400 F. For aromatics or avgas operation; selected straight run naphtha fractions.

Products: Motor fuel operation: Typical product is stable, requires no rerunning, and can be produced at any desired quality to fit marketing requirements.

Aromatics operation: Product contains benzene, toluene, xylenes, and other aromatics. The charge stock, boiling range and unit operating conditions are adjusted to maximize production of the desired individual aromatics. Separation of aromatics from the Platformate is accomplished by Udex solvent extraction, followed by the recovery of individual aromatics in extremely high purity by distillation.

Description: A typical Platforming unit may be divided into three parts: the reactor-heater section in which the charge plus recycle gas is heated and passed over the catalyst; the separation and compression in which the reactor effluent is separated into gas and liquid streams, the gas being compressed for recycling; and the stabilization section in which the separator liquid is stabilized to the desired vapor pressure.

Depending upon the character of the feed stock, it may be desirable to add a recycle gas scrubbing system to remove H_2S from the gas. The Unifining process has proved valuable as a means of producing satisfactory feed stocks from otherwise unsuitable materials.

The principal chemical reactions involved are dehydrogenation of naphthenes to aromatics, dehydrocyclization of paraffins, hydrocracking of high molecular-weight paraffins to lower molecular-weight paraffins, isomerization of paraffins and of naphthenes, and desulfurization of sulfur compounds, forming hydrogen sulfide.

Operating Conditions: The four major process variables are temperature, space velocity, pressure and hydrogen recycle rate. The reactor temperature is normally in the range of 850-980 F. when operating at pressures from 200-800 psig.

Yields: Platformates produced from a Mid-Continent naphtha under three different operating conditions are shown in the table.

Commercial Installations: Platforming is the pioneer catalytic reforming process employing a platinum-containing catalyst. Units from 200 to 29,000 barrels per stream day are in commercial operation.

Reference: PETROLEUM REFINER, vol 31, no. 5, p 97 (May, 1952).

	Charge Stock	PLATFORMATES		
		1	2	3
Yield of 10 lb. RVP Plat., L.V. Percent of Charge	.....	101.0	96.8	89.3
Extraneous C_4 Req. to 10 lb. RVP, L.V. Percent of Charge	.....	8.2	6.2	1.8
RVP, psi	0.2	10.0	10.0	10.0
Octane Ratings:				
F-1 Clear	32.4	85.0	90.0	95.0
+ 3cc TEL/Gallon	56.4	95.5	98.5	iso+0.12
Percent Sulfur	0.04	.....	.....	.....
Molecular Weight	128	.....	.....	.....
UOP "K"	11.93	.....	.....	.....
Debutanized Gasoline:				
°API	52.6	48.0	46.8	44.8
100 Ml. Dist. °F:				
IBP	230	144	140	132
10 Percent	255	200	191	173
50 Percent	**308**	**285**	**281**	**272**
90 Percent	372	366	366	365
95 Percent	382	384	386	389
End Point	397	410	412	413

Powerforming—ESSO RESEARCH AND ENGINEERING COMPANY

Application: Produces Powerformates of 85-100+ Research Octane Number clear from low-octane naphthas. Alternatively, the process may be operated to produce aviation blending stocks or to give high yields of aromatics. Powerforming also produces large quantities of hydrogen.

Charge: Typically low-octane naphthas in the boiling range from 160 to 400 F.

Products: Typical yields and product quality information for 100 Research Octane Number clear Powerformates are shown in Table 1. Powerformers also produce large volumes of by-product hydrogen which may be used to desulfurize the feed and to improve the quality of other refinery products.

Description: Powerforming is a fixed-bed catalytic reforming process employing a new platinum catalyst. The naphtha feed to a Powerformer is desulfurized in a Hydrofining unit. After stripping to remove hydrogen sulfide, the feed is combined with hydrogen-rich recycle gas from the Powerformer separator drum. This mixture then flows in series through 3 or 4 reactors each of which is preceded by a fired heater. The effluent from the last reactor is cooled and passes to the separator drum. The Powerformate from the separator drum is stabilized in conventional equipment. Part of the gas from the separator drum is recycled to the first reactor. The net hydrogen produced is used to desulfurize the feed and to treat other refinery products.

The Powerforming catalyst is regenerated periodically to restore its activity and selectivity. For processing average feed stocks to Research Octane Numbers clear of 98 or less, a semi-regenerative design is employed. In this type of Powerformer, the unit is taken off stream at intervals of 2 to 6 months while all of the reactors are regenerated.

For processing poor quality feedstocks to 100 Research Octane Number clear or higher, a cyclic regeneration system is used. In a cyclic Powerformer, reactors are regenerated individually without taking the unit off stream and an additional "swing" reactor is provided which replaces each on-oil reactor as its catalyst is being regenerated. The rugged supported platinum catalyst maintains its activity and selectivity for years despite frequent regenerations.

Commercial Installations: The first commercial Powerformers were put in operation during the summer of 1955. By the end of 1958, 21 units will have been placed on-stream. Nine additional units are in the planning stage, as indicated in Table 2.

Reference: PETROLEUM REFINER, vol 36, no 9, p 221 (Sept, 1957).

TABLE 1—Powerformer Feed and Products

CRUDE	Arabian	Arabian	Louisiana	West Texas
FEED STOCK				
Gravity, °API	61.6	49.6	55.0	53.0
F-1 O.N., clear	42	26	58	56
ASTM Distillation, °F				
5 Percent	190	310	223	235
50 Percent	236	342	253	260
95 Percent	294	380	304	291
YIELDS				
C_5 plus, vol. percent	63.0	77.5	77.5	81.0
H_2, wt. percent	1.0	1.1	2.1	2.0
C_1-C_3, wt. percent	18.8	10.3	9.7	8.4
C_4, vol. percent	16.6	9.0	8.8	7.8
PRODUCT QUALITY (C_5 plus)				
RVP, psi	7.4	3.3	4.0	3.5
F-1 O.N., clear	100	100	100	100
F-1 O.N. + 3cc. TEL	105.6	105.6	105.6	105.6
F-2 O.N., clear	88.6	88.6	88.6	88.6
F-2 O.N. + 3cc. TEL	94.6	93.2	93.1	93.1

TABLE 2—Powerforming Installations

Company	Location	Capacity B/SD	F-1 O.N. Clear	Type(†)	Start-Up Date
Esso Std. Oil Co.	Baltimore, Md.	3,000	95	SR	July, '55
Imperial Oil Ltd.	Edmondton, Alta.	2,000	85	SR	Aug., '55
Carter Oil Co.	Billings, Mont.	2,500	85	SR	Feb., '56
Raffineria Garrone*	Genoa, Italy	5,600	95	Cy	Jan., '57
Imperial Oil Ltd.	Sarnia, Ont.	15,000	95	SR	Feb., '57
Imperial Oil Ltd.	Montreal, Quebec	9,000	95	Cy	July, '57
Imperial Oil Ltd.	Halifax, N. S.	7,000	95	Cy	Aug., '57
Rasiom*	Augusta, Sicily	7,300	100	Cy	Aug., '57
Stanic	Bari, Italy	7,300	100	Cy	Aug., '57
Esso Std. Oil Co.	Linden, N. J.	20,000	98	Cy	Oct., '57
Esso Std. Italiana	Trieste, Italy	1,000	91	SR	Oct., '57
Esso Std. Oil Co.	Everett, Mass.	7,200	98	SR	Nov., '57
Esso Std. Oil S.A.	Belot, Cuba	2,650	85	SR	Jan., '58
Imperial Oil Ltd.	Ioco, B.C.	5,500	98	Cy	Mar., '58
International Ref. Inc.*	Wrenshall, Minn.	2,800	95	SR	May, '58
Imperial Oil Ltd.	Winnipeg, Manitoba	3,000	98	Cy	May, '58
Esso Std. Ref., S.A.	Antwerp, Belgium	5,800	100	Cy	(1958)
Esso Std. Oil Co.	Baton Rouge, La.	26,900	100.5	Cy	(1958)
Esso Std. S.A.F.	Port Jerome, France	14,500	100	Cy	(1958)
Cie. Francaise de Raff.*	La Mede, France	20,000	98	Cy	(1958)
Standard-Vacuum Oil Co.	Durban, S. Africa	5,630	80	SR	(1958)
Esso Petr. Co. Ltd.	Fawley, U.K.	21,000	101.5	Cy	(1959)
Esso Std. S.A.F.	Bordeaux, France	9,000	100	Cy	(1959)
Irish Ref. Co. Ltd.*	Whitegate, Eire	9,000	100	Cy	(1959)
Standard-Vacuum Oil Co.	Shimizu, Japan	4,830	100	Cy	(1959)
Esso A.G.	Cologne, Germany	9,000	100	Cy	(1959)
Govt. Oil Ref. Admin.*	Baghdad, Iraq	5,000	100	Cy	(1959)
Esso Nederland N.V.	Rotterdam, Neth.	16,500	101.5	Cy	(1960)
Esso Petr. Co. Ltd.	Milford Haven, U.K.	16,500	101.5	Cy	(1960)
A/S Esso-Raffineriet	Slagen, Norway	7,200	100	SR	(1960)
Total		271,510			

* Licensee.
† SR: Semi-Regenerative; Cy: Cyclic.

SBK Catalytic Reforming— THE M. W. KELLOGG COMPANY

Application: For reforming low-grade naphthas to aromatic, high-octane gasoline using a fixed-bed platinum containing catalyst developed by Sinclair and Baker.

Charge: Light, heavy and full-boiling range virgin naphthas, including those from high-sulfur crudes. Thermally and catalytically cracked naphthas are also reformed successfully after preliminary treatment by Kellogg hydrogen desulfurizing.

Product: Premium or aviation gasoline ranging from 85 to more than 100 F-1 clear octane number, depending upon requirements. The reformate is a rich source of pure aromatics. SBK reforming also produces significant amounts of isobutane for alkylation and hydrogen for upgrading other refinery streams.

Description: A typical SBK reformer designed to produce 95 to 100 F-1 clear octane reformate would consist of three principle parts; a pretreat or catalytic desulfurization section, the reforming section proper, and the reforming catalyst regeneration equipment. Feed naphtha is charged through an absorber to the high pressure desulfurizer, along with hydrogen rich gas produced in the unit, for removal of harmful metallic, nitrogen, and arsenic compounds, desulfurization, and saturation of olefinic compounds. The desulfurizer effluent passes through a stripper, is joined by hydrogen-rich recycle gas, and receives preheat to reforming temperature prior to entering the first reforming reactor.

The reforming section can contain up to five reactors, the first three in series flow, and the last two in parallel. Three reheat furnaces are interposed between the reaction steps. The effluent from the final reactor is passed through reboilers and coolers to the high pressure separator where the total reactor effluent is separated into liquid and gas fractions. The gas, high in hydrogen content, is compressed and recycled to the inlet naphtha feed system. The liquid fraction is fed to a column for stabilization to produce the debutanized reformate product. Hydrogen is produced in excess of process requirements and may be utilized in other processes.

Operating cycles are a function of feed characteristics and octane severity. However, they are comparatively long. Catalyst is regenerated in place. Any of the three terminal reactors may be shut down for regeneration with no marked disturbance to the operation. When a reactor is being regenerated the remaining four are operated in series; the first two reactors need be regenerated only when the unit is shut down for turnaround.

Operating Conditions: The preferred range of reactor conditions is 200-500 psig and 875-975° F., with a recycle gas rate of 5000-8000 SCF/Bbl feed.

Yields: The following data give typical yields for reforming Mid-Continent and Kuwait virgin naphthas in the 200-400 F. boiling range:

Feedstock	Mid-Continent		Kuwait	
Gravity, °API	54.6		57.2	
Paraffins, Vol %	51.0		59.7	
Naphthenes, Vol %	38.3		24.6	
Aromatics, Vol %	10.7		15.7	
Reformate				
F-1 clear octane	95	100	95	100
Yield C_6+ reformate, Vol %	81.4	76.9	78.2	73.2
Yield C_4's, Vol %	6.2	7.8	7.2	8.8
Yield dry gas, Wt %	9.8	12.3	10.4	12.8

Economics: Installation costs are $125-350 per barrel for capacities from 3000 to 30,000 bpsd. Typical operating costs for a 10,000 bpsd unit are given below.

Feedstock Source	Kuwait		Mid-Continent	
Product octane-F-1 clear C_6+	90	95	90	95
Operating cost, ¢/bbl feed				
Fuel @ $0.90/bbl.	5.2	5.2	5.2	5.2
Power @ $0.007/KWH	2.0	2.3	2.0	2.0
Water @ $0.007/1000 gal.	0.5	0.6	0.5	0.5
Catalyst (reforming)	6.8	10.8	4.0	6.7
Catalyst (desulfurizing)	0.5	0.5	0.5	0.5
Labor @ $55/day	1.4	1.7	1.4	1.4
Supervision @ 15% Labor	0.2	0.2	0.2	0.2
Total direct operating cost	16.6	21.3	13.8	16.5
Maintenance @ 4% process equipment investment	2.2	2.5	2.2	2.3
Property taxes & insurance @ 2% process investment	1.5	1.8	1.4	1.6
Interest @ 4% total process investment	3.0	3.6	2.8	3.2
Depreciation @ 10% process equipment investment	5.5	6.2	5.5	5.7
Total operating cost, ¢/bbl feed	28.8	35.4	25.7	29.3

Commercial Installations: Sixteen units designed by Kellogg for this catalyst are operating or under construction having a total charge capacity of 126,525 bpsd. Industry wide, 50 reforming units have been or are being designed for Sinclair-Baker catalyst, representing a combined charge capacity of 403,775 bpsd.

Reference: Petroleum Refiner, vol 34, no 9, p 190 (Sept, 1955).

Ultraforming—STANDARD OIL COMPANY (INDIANA)

Application: To convert low-octane naphthas to high-octane blending stocks. Ultraforming is especially designed to produce gasoline blending stocks with clear-octane ratings up to 102-104* without the use of auxiliary processes.

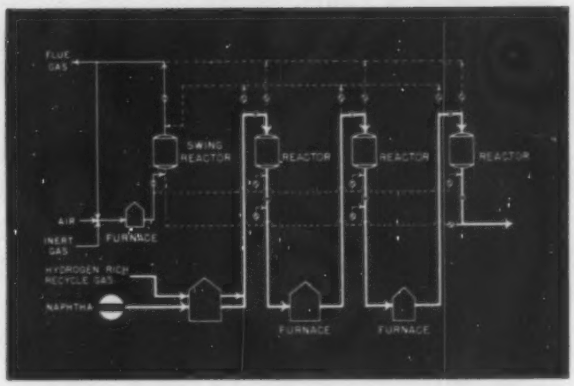
Charge: Either straightrun or mixtures of straightrun and cracked naphthas. Because the process has regeneration facilities, boiling range of the charge is not critical. Selected fractions of straightrun naphtha may be processed for avgas or aromatics operations.

Product: Typical commercial operations give reformates of 95-102 F-1 octane number, clear. Total Ultraformate may be split into a light and heavy fractionation by distillation to obtain a C_7+ blending stock having a clear-octane rating of 108-110.

Description: Ultraforming is a regenrative, fixed-bed catalytic reforming process employing several distinctive process features. Frequent on-stream catalyst regeneration is made possible by a unique process design which includes a swing reactor. When catalyst activity in an on-stream reactor declines, that reactor is temporarily replaced by the swing reactor. Reforming operations continue while catalyst in the isolated reactor is regenerated in situ with air and inert gas. After regeneration, the freshly regenerated reactor is placed back on stream and the swing reactor is again available to replace any other reactor in the system. The valve and piping arrangement used to switch reactors is shown in the accompanying flow diagram.

Other distinctive Ultraforming features are low reaction pressures, low gas recycle rates and a special catalyst regeneration technique. The combination of Ultraforming's swing-reactor design, catalyst regeneration technique and operating conditions result in maximum octane potential, higher gasoline and hydrogen yields and greater process flexibility.

* For octane numbers over 100, the Wiese extension of the octane scale is used.



Ultraforming catalyst, has been successfully regenerated more than 200 times in commercial units. Several commercial installations have now attained catalyst lives between 100-200 barrels per pound and catalyst activity in these units is still being maintained at initial activity.

Operating Conditions: Usually a reactor pressure of about 200-300 psi and a reactor-inlet temperature of 900-950 F. Hydrogen recycle rate and space velocity are adjusted to the particular characteristics of the charge and to the product desired.

Yields: Ultraforming yields from severe reforming of Gulf Coast, Mid-Continent and Kuwait naphthas are shown in the accompanying table.

Commercial Installations: A total of 25 commercial Ultraforming units of Standard, its affiliates and licensees, are operating.

ULTRAFORMING YIELDS

	Gulf Coast		Mid-Continent		Kuwait	
Charge Naphtha						
ASTM Dist., °F.						
Initial	238		200		193	
10 percent	263		230		220	
50 percent	304		262		266	
90 percent	357		316		330	
End Point	400		362		366	
Composition, Volume Percent						
Paraffins	35		51.3		68.5	
Naphthenes	51		36.2		20.5	
Aromatics	14		12.5		11.0	
F-1 Octane No., Clear	42.8		48.4		35	
Products						
C_5+ Reformate						
F-1 Octane No., Clear	100	103.5	98	102	95	100
Yield, Volume percent	80.9	75.5	79.4	71.7	74.6	63.1
RVP psi	2.9	3.5	3.4	4.2	5.2	6.0
Butanes, Volume percent	5.1	7.1	6.6	9.9	11.3	16.2
Dry Gas, Weight percent	8.8	12.2	10.1	14.7	13.0	20.2
Hydrogen scf/bbl	1330	1330	1100	1100	680	705
10-psi Gasoline						
F-1 Octane No., Research Clear	100	103.5	98	102	95	100
Yield, Volume Percent	89.7	81.0	88.1	78.5	80.1	66.8

Iso-Plus Houdriforming— HOUDRY PROCESS CORPORATION

Application: Combines conventional catalytic Houdriforming with either thermal reforming or aromatics separation to convert low-octane naphthas into high-octane gasolines.

Charge: A wide variety of feed stocks, differing substantially in chemical composition and having final boiling points up to 400 F.

Product: Gasoline in the range of 100 and higher F-1 octane numbers clear.

Description: Flow diagrams for each of the three Iso-Plus routes are presented herewith.

In each of the three Iso-Plus routes, virgin naphtha feed is first charged to a Houdriformer pretreat (guard case) section consisting of heater and catalytic reaction chamber, and thence to a stripper tower venting H_2S and other contaminants to fuel. Effluent moves to the Houdriformer's three heaters and catalytic reactors in series. Operating conditions for Houdriforming are mild in all three Iso-Plus variations.

Iso-Plus with thermal reforming yields an 87 F-1 clear Houdriformate. This is depropanized and depentanized, with propanes going to refinery fuel, and butanes and pentanes taken for final blending. The depentanized effluent undergoes thermal reforming, and is flashed and debutanized. The thermal C_3-C_4 olefins are polymerized catalytically and this product gasoline goes to blending with the reformate, butanes and pentanes.

In one of the Iso-Plus designs employing aromatics separation, the 87 F-1 clear Houdriformate is flashed, depropanized, depentanized; butanes and pentanes go to product. Depentanized effluent is charged to aromatics extraction, with a 91 percent aromatics concentrate separated as product. An 81 percent paraffinic raffinate moves to a second Houdriforming stage, yielding 81 F-1 clear Houdriformate for flashing and depropanizing. The final blend of 100 octane F-1 clear gasoline consists of the aromatic concentrate, butanes and pentanes from the first Houdriforming stage, and depropanized Houdriformate from the second Houdriformer. As a variation to this alternative, second-pass Houdriformate may be recycled to aromatics extraction, making it possible to recover more than 80 percent of naphtha feed as 108 F-1 clear octane 10 lb. RVP gasoline.

The second Iso-Plus aromatics separation design eliminates the second Houdriforming stage, and provides for depropanizing, debutanizing and depentanizing an 83 F-1 clear Houdriformate. Most of the butanes and part of the debutanized reformate go to final product. Depentanized Houdriformate undergoes aromatics extraction; concentrate goes to product and paraffinic raffinate recycles to the Houdriforming section.

Yields: Experimental runs of Iso-Plus aromatics extraction variations have achieved yields of 100 octane F-1 clear gasoline of up to 91 percent of naphtha feed. One of these variations, with slight operational modification, yields 82 percent of charge as 108 F-1 clear gasoline. Iso-Plus Houdriforming using supplemental thermal reforming yields 80 to 90 percent of reformed gasoline, depending upon desired octane value of final product.

Commercial Installations: Iso-Plus Houdriforming is in commercial operation in two variations. Houdriforming coupled with thermal reforming is being used in a 4000 bpsd unit in Italy which charges naphtha from Middle East crudes. This unit has produced reformate having F-1 clear octane ratings as high as 104.

Houdriforming coupled with aromatics extractions and recycle of raffinate is being used in a large domestic unit which processes naphthas principally from Middle East crudes. F-1 clear octane product above 100 is produced.

Reference: PETROLEUM REFINER, vol 34, no 9, p 135 (Sept, 1955).

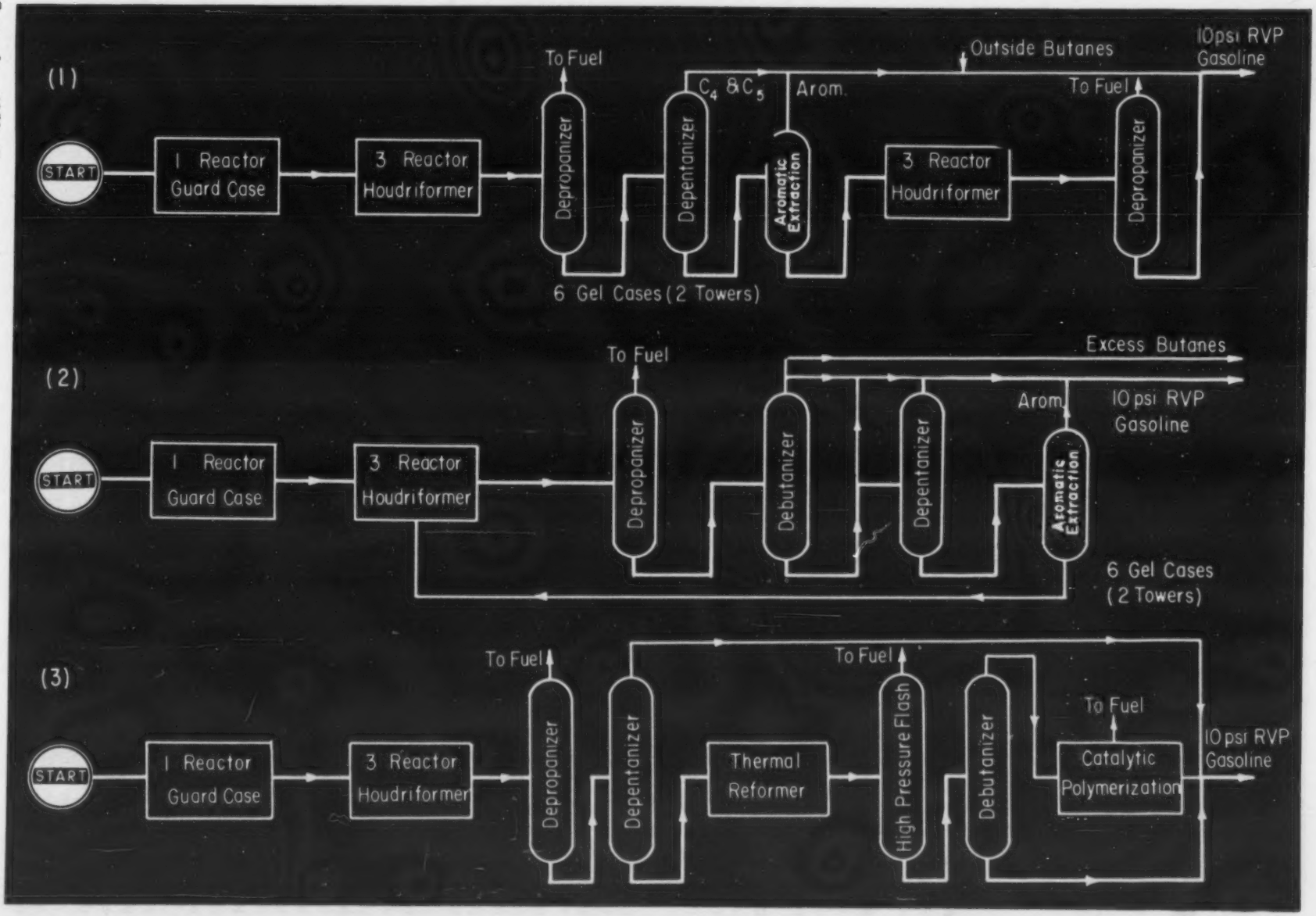
Table 1—Inspections of Reformer Charge

Gravity, °A.P.I.	51.0
Distillation, °F.:	
I.b.p.	200
10 percent	230
50 percent	295
90 percent	365
End point	394
Sulfur, weight percent	0.125
F-1 clear octane	54.1
Composition, volume percent:	
Paraffins	46
Olefins	—
Naphthenes	37
Aromatics	17

TABLE 2—Comparative Yields and Process Streams of Iso-Plus Houdriforming Processes

	Houdriforming Plus Aromatics Extraction		Houdriforming Plus Thermal Reforming
Reformer feed, bpsd			
Feed to pretreater	6,600	6,600	6,600
Recycle raffinate	.....	3,531	.....
Total	6,600	10,131	6,600
Yields from reforming:			
Reformate, C_5+	5,003	8,753	5,900
Butanes	271	574	271
Fuel gas, F.O.E.	422	818	422
Reformate octane, F-1 clear	87.0	83.0	87.0
Charge to debutanizer	.....	9,327	6,171
Charge to depentanizer	6,171	7,068	.....
Depentanizer bypass stream	.....	1,685	.....
Charge to aromatics separation	5,603	6,545	.....
Aromatic concentrate	3,174	3,014	.....
Raffinate	2,429	3,531	.....
	Houdriform Raffinate		**Thermal Reform Reformate**
Yields from Second Pass Reforming:			
Reformate, C_5+	1,932	.....	4,807
Heavy polymer	.....	.....	33
Butanes	246	.....	143
Butenes, recovered from cat. poly chg.	.....	.....	273
Propene, recovered from cat poly chg.	.....	.....	183
Fuel gas, F.O.E.	293	.....	491
Catalytic polymer gasoline	.....	.....	328
Reformate octane, F-1 clear	81.0	.....	99.6
Over-all Yields:			
Butane free gasoline	5,403	5,222	5,135
Butanes for 10-lb. R.v.p.	590	529	536
Total 10-psi R.v.p. gasoline	5,993	5,751	5,671
Excess butanes	*73	45	*122
Fuel gas, F.O.E.	715	818	913
F-1 clear octane of 10-psi R.v.p. gasoline	100.0	100.0	100.0

* Outside butanes required.


(1)
START
1 Reactor Guard Case
3 Reactor Houdriformer
Depropanizer
To Fuel
Depentanizer
C4 & C5
Arom.
Aromatic Extraction
Outside Butanes
3 Reactor Houdriformer
To Fuel
Depropanizer
10psi RVP Gasoline
6 Gel Cases (2 Towers)
(2)
START
1 Reactor Guard Case
3 Reactor Houdriformer
Depropanizer
To Fuel
Debutanizer
Depentanizer
Arom.
Aromatic Extraction
Excess Butanes
10 psi RVP Gasoline
6 Gel Cases (2 Towers)
(3)
START
1 Reactor Guard Case
3 Reactor Houdriformer
Depropanizer
To Fuel
Depentanizer
Thermal Reformer
High Pressure Flash
To Fuel
Debutanizer
To Fuel
Catalytic Polymerization
10 psi RVP Gasoline

Rexforming—UNIVERSAL OIL PRODUCTS COMPANY

Application: Produces a product having an unleaded Research octane rating ranging upwards from 98-100 when charging a normal, full boiling range gasoline.

Product: The Rexformate product consists of 58 percent or more aromatics, approximately 5 percent naphthenes, olefins in trace amounts. The balance is high-octane, relatively low-boiling paraffins.

Description: Rexforming is a combination process, as indicated in the flowsheet, employing elements of the UOP Platforming method of catalytic reforming in conjunction with some steps of the Udex technique for recovering aromatics.

When charging a full boiling range gasoline, a prefractionator is used to prepare a 180 or 200 degrees IBP to 400 degrees EP heart cut as a side-stream which constitutes feed to the catalytic section. This section employs the Platforming catalyst and flow through it is similar to that in the catalytic section of a Platforming unit. The reactor effluent is flashed to recover hydrogen produced in the process as net make and for recycling. The remaining liquid is stablized to desired vapor pressure and initial boiling point.

The stabilized reactor effluent then is contacted countercurrently in a specially designed extractor column with an aqueous solution of glycol. The overhead, or raffinate, product from this column contains essentially all of the high-boiling, low-octane paraffins. This stream is recycled to the reactor section via the prefractionator feed, whence it appears in the heart cut previously mentioned. The bottom, or extract, product is stripped of dissolved hydrocarbons in the last column. The stripper overhead is Rexformate. The bottom product is solvent of the desired composition to effect the recovery of Rexformate and is recycled to the extractor.

Severe catalytic reforming conditions are unnecessary to secure a "super fuel" from the octane standpoint. This makes for long catalyst life and high yields and reduces equipment maintenance costs in comparison with once-through catalytic reforming to the same octane level.

The extractor column conditions are set to control the quality of the Rexformate, rather than the reactor conditions as in Platforming. Reactor conditions are set for the optimum conversion of hydrocarbons in the total reactor feed into high octane compounds.

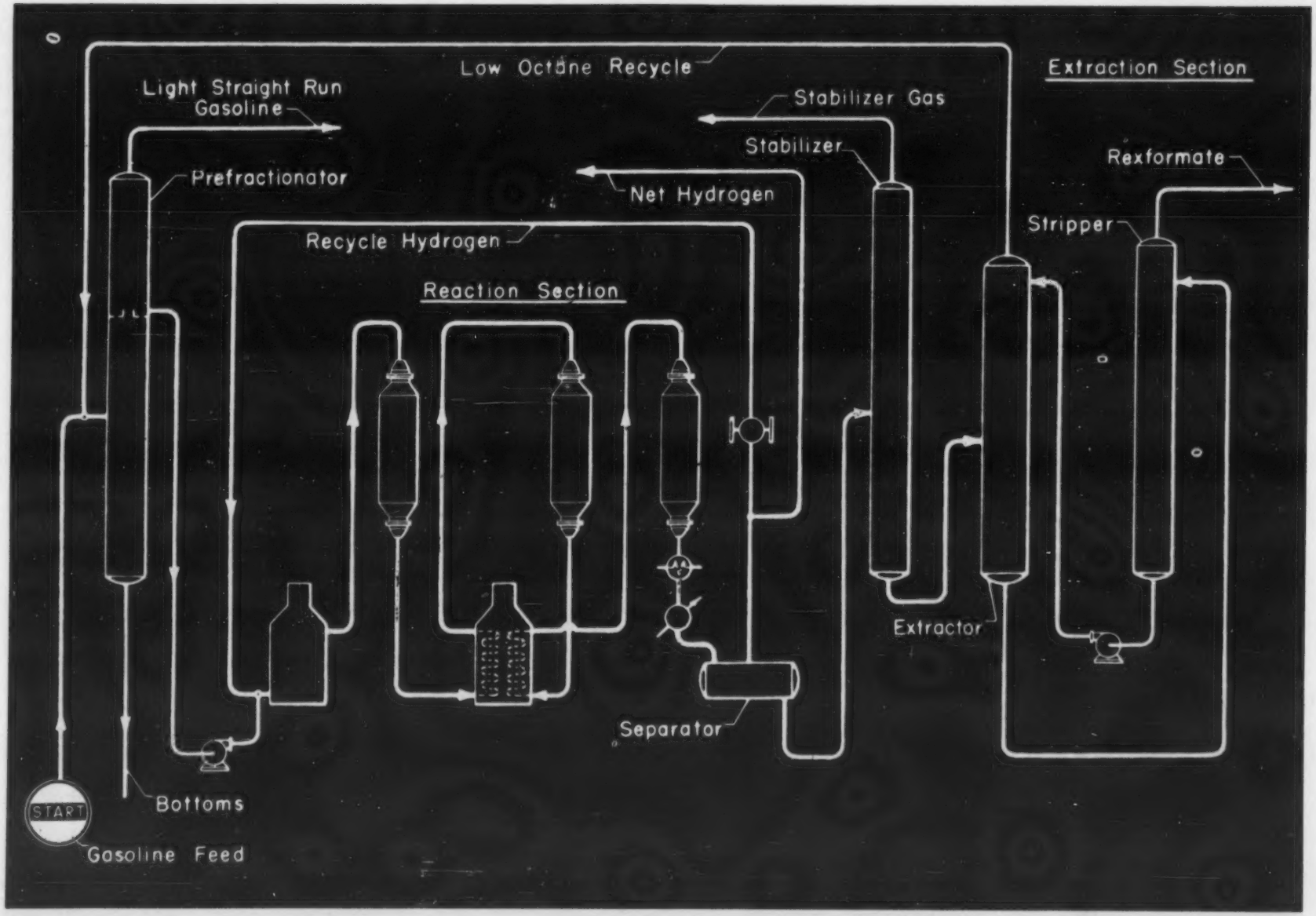
Since the raffinate is a recycle stream rather than a final product in Rexforming, there are no "losses" of high octane materials to a low-quality stream. This permits important equipment simplification and operating economies because the separation between raffinate, and extract need not be extremely sharp.

Yields: The superlative quality of Rexformate is indicated in the accompanying data tabulation:

	Reactor Combined Feed	Debutanized Rexformate
Gravity, °API	56–58	42
ASTM Distillation:		
Intial Boiling Point, F	180	110
10 Percent	215	160
30 Percent	240	210
50 Percent	**260**	**240**
70 Percent	287	275
90 Percent	334	330
End Point	380	410
Sulfur, Weight Percent	0.055	0.001
Hydrocarbon Type, Volume Percent:		
Paraffin	60.5	35
Olefin	Trace	0
Naphthene	33.5	5
Aromatic	6.0	60
Reid Vapor Pressure	.....	3.6
Octane Rating:		
Research, Clear	.....	98.0 (min.)
+ 3 ml. TEL	.....	iso C_8 + 0.19 ml. TEL
Yield, Volume Percent Fresh Feed, Estimated	.....	81.0

Commercial Installation: Several all-new Rexforming units have been placed on-stream and have demonstrated the capability to produce high quality products. Several Platforming units also have been converted to Rexforming, while a number of other Platformers contain provisions for future conversion to Rexforming.

Reference: PETROLEUM REFINER, vol 34, no 4, p 116 (Apr, 1955).


Low Octane Recycle
Extraction Section
Light Straight Run Gasoline
Stabilizer Gas
Stabilizer
Rexformate
Prefractionator
Net Hydrogen
Stripper
Recycle Hydrogen
Reaction Section
Extractor
Separator
START
Bottoms
Gasoline Feed

Fluid Hydroforming—ESSO RESEARCH AND ENGINEERING COMPANY

Application: To convert virgin and cracked naphthas to high-octane gasoline.

Charge: A great variety of feed stocks has been reformed to products in the 90 to 100-octane number range. Middle East naphtha has been Hydroformed commercially to over 100 research octane clear. Both narrow- and wide-cut feeds have been processed. There is no limitation on feed end point, and feeds containing cracked stocks can be reformed with excellent yields without pretreatment for olefin saturation or sulfur removal. Yields from fluid Hydroforming at any octane level depend on the feed-stock quality.

Product: Principal product is a high-octane naphtha which can be used in motor gasoline directly or extracted for aromatic blending stocks for aviation gasoline. The liquid products are essentially sulfur-free. The tail gas produced in Fluid Hydroforming can be used for hydrofinishing other refinery stocks for sulfur removal.

Description: The finely-divided molybdena-alumina catalyst, behaving much like a fluid, circulates continuously between the reactor and the regenerator. The catalyst is cheap and rugged, and not susceptible to poisoning by sulfur or water. The feed stock does not require pretreating for sulfur removal. Selectivity of the catalyst does not fall off with continued use.

The preheated naphtha feed enters the bottom of the reactor where it meets a hot isothermal bed of catalyst. The reformed products leave the catalyst bed and pass through separators where entrained catalyst is removed and returned to the bed. The overhead products are heat exchanged, cooled and separated into gaseous and liquid products.

After stabilization, the liquid product is removed as high-octane gasoline. A portion of the gaseous product is compressed, heated, and recycled to the reactor to supply additional heat.

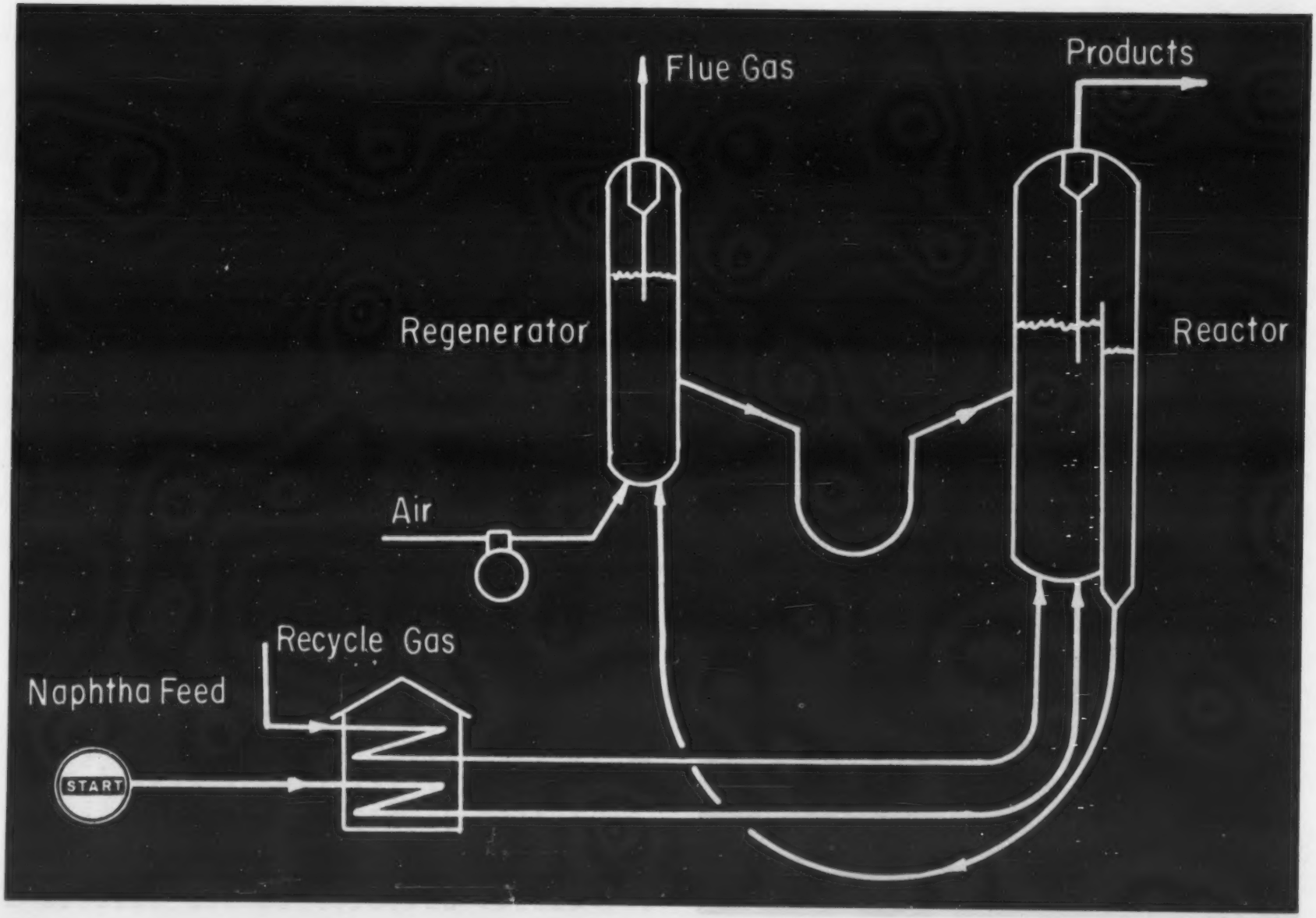
To remove carbon which deposits on the catalyst during the reaction, a portion is continuously withdrawn and allowed to flow to the regenerator. Here carbon is burned off with air which liberates large quantities of heat. The heat may be used to produce steam or preheat the feed. The hot regenerated catalyst returns as a fluidized stream to the reactor, supplying some of the heat required and completing the continuous cycle.

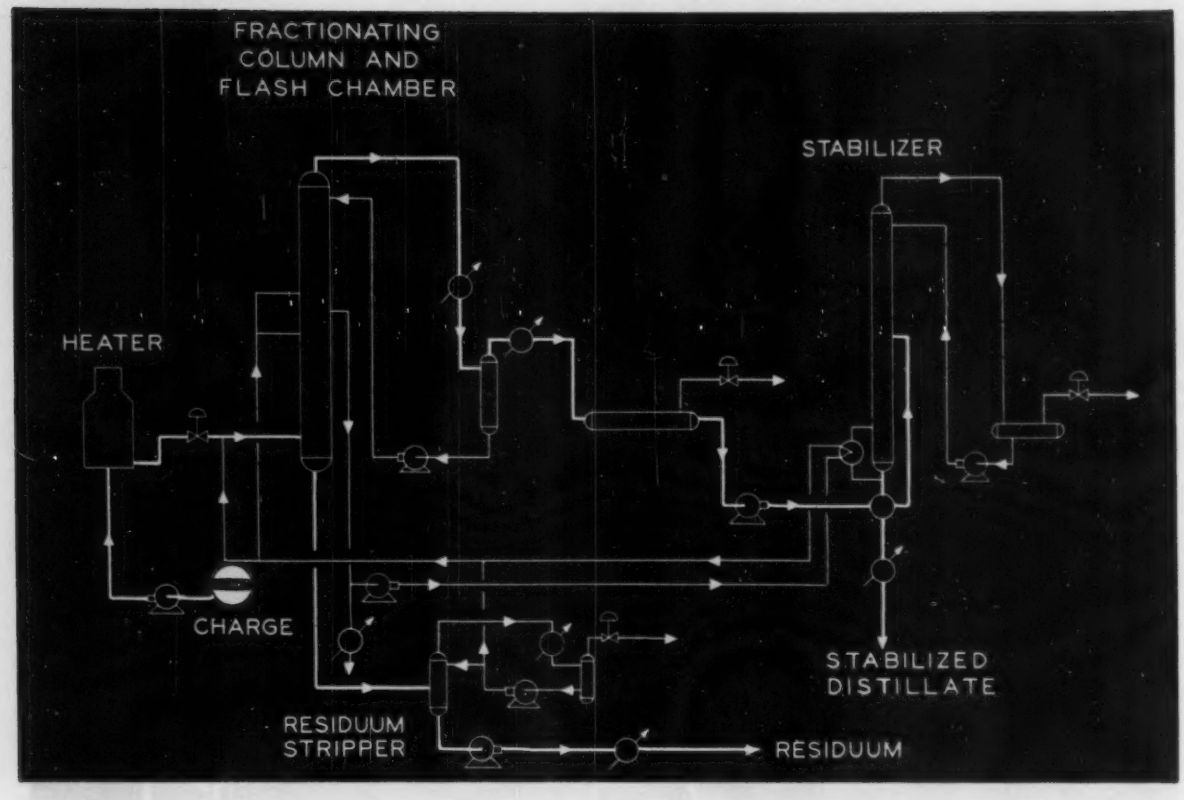
Commercial Installations: The first Fluid Hydroformer went on stream in 1953. Nine others have started up since then. Total capacity of the ten units is 114,230 barrels per stream day, as shown in the table.

Reference: PETROLEUM REFINER, vol 34, no 11, p 214 (Nov, 1955).

Fluid Hydroforming Units

COMPANY	Location	Capacity B/SD	Date on Stream	Builder
American Oil Co.	Destrehan, La.	2,000	1953	M.W. Kellogg
Toa Nenryo Kogyo Co., Ltd. (Standard-Vacuum Oil Co.)	Wakayama, Japan	4,700	Dec., 1954	Toa Nenryo
Cities Service Oil Co.	East Chicago, Ind.	12,780	Jan., 1955	M.W. Kellogg
Cities Service Refining Co.	Lake Charles, La.	17,250	Feb., 1955	M.W. Kellogg
Esso Standard Oil Co.	Baton Rouge, La.	22,200	March, 1955	C.F. Braun
Creole Petroleum Corp.	Amuay, Venezuela	11,100	March, 1955	Foster Wheeler
Arabian American Oil Co.	Ras Tanura, S.A.	12,500	July, 1955	Lummus
Stanic	Leghorn, Italy	8,900	Nov., 1955	CTIP
Esso Petroleum Co.	Fawley, England	15,000	April, 1956	Foster Wheeler
Esso A.G.	Hamburg, Germany	7,800	Aug., 1956	Lurgi
Total		114,230		


Flue Gas
Products
Regenerator
Reactor
Air
Recycle Gas
Naphtha Feed
START



Thermal Reforming—UNIVERSAL OIL PRODUCTS COMPANY

Application: Converts low-octane gasolines and naphthas into higher-octane gasoline. It also produces butane-butylenes and propane-propylene which can be polymerized to produce a high-octane polymer gasoline. The residuum from Thermal Reforming has a high calorific value, and can be marketed as fuel oil.

Description: A straight-run gasoline or naphtha fraction is charged to a heater wherein the reaction time, pressure, and discharge temperature are controlled to produce the desired products. The effluent from the heater passes through a pressure control valve where the pressure is reduced. A quench stream from the fractionator is introduced after the control valve to reduce the temperature of the effluent and minimize coking.

The quenched products enter a combination flash chamber and fractionating column wherein the gas and gasoline are taken overhead, and the small amount of bottoms produced is removed from the lower portion of the vessel. A cracked naphtha side-cut from this column is used for quench and heat exchange duty. Naphtha side-cuts may be withdrawn if desired.

The overhead products from the fractionator are cooled, and the condensed, unstabilized gasoline is sent to a stabilizer to produce the desired vapor pressure. If polymerization of the gases evolved from the cracking operation is desired, an absorber for the receiver gases plus deep stabilization of the gasoline is employed to provide maximum recovery and utilization of polymerizable olefins available.

The bottoms withdrawn from the flash chamber portion of the reformer column are further flashed in a residuum stripper. Light overhead material removed from the residuum at this point is condensed and returned to the fractionating column, whereas the residuum is sent to storage for subsequent disposal as fuel oil. The properties of the residuum are regulated by suitable control of reflux to the stripper.

Yields: A typical result when reforming a 53° API Mid-Continent straight-run naphtha is shown below.

Charging Stock:	
Gravity, °API	53.0
F-2 O.N., Clear	40.5
Characterization Factor	11.96
100 Ml. Distillation, °F:	
Initial Boiling Point	208
10 Percent	263
50 Percent	**314**
90 Percent	367
End Point	389
Products:	
Gasoline:	
Yield, Volume Percent of Charge	81.3
Gravity, °API	56.1
Reid Vapor Pressure, psi	10.0
100 Ml. Distillation, °F:	
Initial Boiling Point	93
10 Percent	145
50 Percent	**270**
90 Percent	360
End Point	398
Octane Ratings:	
F-2 O.N., Clear	70.2
+ 3 cc. TEL/Gallon	81.9
F-1 O.N., Clear	78.2
+ 3 cc. TEL/Gallon	91.3
Residuum:	
Yield, Volume Percent of Charge	4.2
Gravity, °API	18.2
Gas:	
Yield, Weight Percent of Charge	15.3
Cu. Ft./Barrel of Charge	467

Cracking

CRACKING was developed to produce more gasoline from a barrel of crude. Originally started as a thermal process, cracking has progressed so far into the catalytic phase that no new thermal cracking units are now being installed in the U. S. Nevertheless, the themral type still constitute about one third of the total cracking capacity in use today.

Cracking is a phenomenon by which large molecules are decomposed into smaller (and lower boiling) molecules. At the same time some of these molecules combine with one another to give even larger molecules than those in the original charge stock. The more stable molecules leave the system as cracked gasoline, while the reactive ones polymerize, forming cracked fuel oil and coke.

Development of catalytic cracking has been the most dramatic achievement of the refining industry both in capacity (42 percent on crude capacity) and in technological advance (perfection of gas-solids technique).

Catalytic cracking, in contrast to thermal cracking, gives rise to more selective cracking and less light-ends products. In addition, the catalyst is more effective in causing cyclization and some isomerization to produce aromatics, naphthenes and isoparaffins, rather than the predominating dehydrogenation to form olefins that occurs in thermal cracking operation. Use of a catalyst, usually a natural or synthetic aluminosilicate, also results in higher yields of high-octane gasoline without the concurrent production of low-value heavy fuel oil which is always a product of thermal cracking. Higher investment and operating costs of the catalytic process thus are balanced by increased product quality.

In operation, the major process variables are temperature, catalyst/oil ratio and space velocity. Regulation of these variables, along with the extent of internal recycling, makes the cracking proces extremely flexible with respect to product distribution and quality requirements. In practice, recycle varies from 0 to 60 percent of total feed. Now averaging about 24 percent, the trend is towards higher recycle ratios.

More recent trend in catalytic cracking is the use of two reaction stages. The Two Stage Fluid Catalytic Cracking process (p 240) was developed to take advantage of short-contact-time cracking to produce gasoline from the less refractory material. Then the gasoline is removed before the gas oils are subjected to the more destructive cracking of the second stage.

Feed stocks for catalytic cracking may range from naphtha cuts to reduced crudes, but the most commonly employed feed is a gas oil with an initial boiling point higher than the end point of the gasoline to be produced. Thus for aviation gasoline production, the IBP of the feed stock will be 300 F.; and for motor gasoline, above 400 F.

Residual stocks have not been processed in many cases due to excessive coke formation and metal contamination of catalyst. However, advances in operation (such as the Houdresid Process, (p 242) have proven successful with feeds low in metal contaminants.

Usually, feed preparation techniques must be employed to remove salts and asphalts before catalytic cracking operations with heavy stocks. Feed preparation for catalytic cracking may be carried out in one of these ways: Coking, propane deasphalting, furfural extraction, vacuum distillation, viscosity breaking, thermal cracking or hydrodesulfurization. Aim of these processes is to decrease production of residual fuels and make more feed stock available for cracking.

New emphasis is being given cracking processes which are carried out in an hydrogen atmosphere. These hydrocracking processes upgrade fuel oils into more valuable materials by destructive hydrogenation. At first extremely high pressures (3,000-10,000 pounds per square inch) were needed to obtain satisfactory hydrocracking reactions. Now researchers show the process can be achieved at much lower pressures (below 1,000 psi) provided a catalyst is used. The H-Oil Process (p 247) is one of the new hydrocracking processes which has been announced recently for commercial application.

Coking is actually a cracking process which extends the time of cracking so that coke is formed instead of minimizing as in thermal and catalytic cracking. Although design-wise it is very similar to thermal cracking, it has its own set of economic conditions. When market demand and price of residual fuels are low in relation to gasoline, the coking process (which yields gas oil, gasoline, gas and solid coke as products) becomes attractive. This has been the case in recent years but the search for more catalytic cracking feed stocks also has given impetus to the coking boom (now 430,000 bpd in capacity).

Using residual stocks or reduced crude for charge, coking units produce a clean gas oil charge for catalytic cracking. Coking processes are of three types—batch, delayed and fluid. The batch process, rapidly becoming extinct, deposits coke in a shell still which must be shut down periodically to remove the accumulated coke. The delayed process, which is semi-continuous, deposits coke in a drum immediately after the reaction heater. The drum is taken off stream periodically to remove the coke.

Fluid coking uses coke particles as seeds in the formation of coke. These coke particles are removed continuously from a fluidized bed. Major advantages claimed for this fluid process are its continuous nature, made possible by the coke circulation system which requires minimum physical handling, and the fact that the process normally requires no external furnace.

Visbreaking is a variation in thermal cracking in which the charge stock is residual fuel oil or reduced crude and is cracked under such mild conditions (short-time decomposition and mild temperatures) that coke formation is minimized. Thus the viscosity of the fuel oil is reduced and a clean gas oil is produced for further cracking. Coking is now the more popular process for handling such stocks.

These thermal schemes used for cracking of individual charge stocks are often assembled into "combination" units (p 249) which accomplish the complete processing of a crude oil. The combination of several process steps into a single unit offers good opportunity for saving in operating equipment and utilities, e.g., heaters and exchangers.

A review of these processes is given in the comprehensive article by Marshall Sittig on "Catalytic Cracking Techniques in Review," PETROLEUM REFINER, vol 31, no 9, pp 263-316 (Sept, 1952).

Airlift TCC—SOCONY MOBIL OIL COMPANY, INC.

Application: The Thermofor Catalytic Cracking process is used primarily to (1) produce high quality gasoline, (2) increase the yield of distillate fuel fractions, and (3) reduce the yield of residual fuels. By-products of TCC operations are large yields of valuable feed stocks for alkylation and catalytic polymerization units.

Charge: In commercial practice a wide variety of feed stocks are charged to these units. Full range gas oils either virgin or previously processed are concurrently employed and in some cases whole crude may be charged. The feed is sometimes supplemented with straight-run naphtha in order to realize an octane number improvement and a degree of desulfurization.

Products: The flexibility of the process and the available range of operating conditions permit variations of product distribution. Thus, gasoline, octane rating, or burning fuels may be maximized to fit the economics of the particular refinery. The high ratio of isobutane to butenes is advantageous where secondary processing includes alkylation.

Description: The first commercial TCC unit was placed on stream in 1943. In 1950 the first Airlift TCC was started up, in which the original design was modified by superimposing the reactor over the kiln and replacing the bucket elevators with a catalyst airlift. These changes resulted in reduced investment costs, simplified operation and improved flexibility. Continuing progress in design improvements have given existing units increases of up to 80 percent in reactor and kiln capacity at little modification expense. Referring to the accompanying flow diagram, the charge is first heat exchanged against fractionator streams, combined with recycle (if any), heated and charged to the reactor as a mixture of vapor and liquid. Alternate feed preparation systems may employ a tar separator and a vacuum jug, or some prior processing step such as visbreaking, coking or propane deasphalting.

In the catalytic section regenerated catalyst slowly flows by gravity down the seal leg from the surge hopper to the reactor. Sealing steam or flue gas flows countercurrently upwards, thereby permitting the pressure to increase from atmospheric in the surge hopper to as much as 15 psig in the reactor. In the reactor, catalyst flows slowly through a reaction bed of uniform depth, past vapor collecting grids, through a purge zone, and out of the reactor. The purged spent catalyst from the bottom of the reactor gravitates into the top of the kiln and then through the kiln where it first contacts flue gas of low oxygen content in the upper (countercurrent flow) section. As the catalyst passes downward in the kiln, its temperature is raised by the combustion of the coke, and then reduced by the incoming air. In the lower section of the kiln the air and catalyst flow concurrently downward, the flue gas is disengaged and the catalyst passes to the coolers. These coolers remove excess heat of coke combustion by generating steam and are controlled to cool the catalyst to the desired temperature for return to the reactor section. The regenerated catalyst flows from the coolers into the lift pot where it is picked up by low-pressure air (introduced at 2 to 3 psig) and lifted to the surge hopper at the top of the unit. The catalyst is separated from the lift air in the surger hopper and flows slowly down the seal leg to complete the cycle.

The effluent vapors from the reactor flow to simple fractionating and gas recovery systems to separate the cuts desired for blending into final refinery products. The TCC reactor effluent contains essentially no inert gases that would increase recovery problems.

Synthetic bead catalyst are generally preferred for use in these units. DURABEAD catalyst, now in production, has all the yield and stability advantages of the former Standard Chrome Bead Catalyst plus greatly increased structural strength and carbon burning capacity. Commercial test data indicate that average DURABEAD catalyst usage will be less than 0.17 pounds per barrel of feed.

Operating Conditions: A wide range of flexibility allows conditions to be tailored to any feedstock. Typical values are: reactor space velocity 1-2.5 (Vol./Hr./Vol.), catalyst-to-oil ratio 2-5 (volume), average reactor temperature 840-950 F., and recycle to fresh feed ratio 0-2 (volume).

Yields:

Crude Type	Mid-East & Venezuela	Kansas
Yields:		
Gasoline, Vol. %	43.3	56.3
Light Cycle Stock, Vol. %	27.1	15.0
Heavy Cycle Stock, Vol. %	18.6	17.0
Butanes, Vol. %	7.5	10.8
Propanes, Vol. Wt.	6.3	8.8
Ethane and Lighter Gas, Wt. %	3.5	2.3
Coke, Wt. %	5.8	5.2
Properties:		
Charge Stock, Gravity, °API	27.3	26.5
10% Distilled, °F	670	657
50% Distilled	872	835
90% Distilled	995	1021
Gasoline, RVP	10.0	10.5
10% Distilled, °F	115	137
50% Distilled	208	230
90% Distilled	360	395
F-1 O.N. + 3 cc TEL/Gal.	96.6	97.2

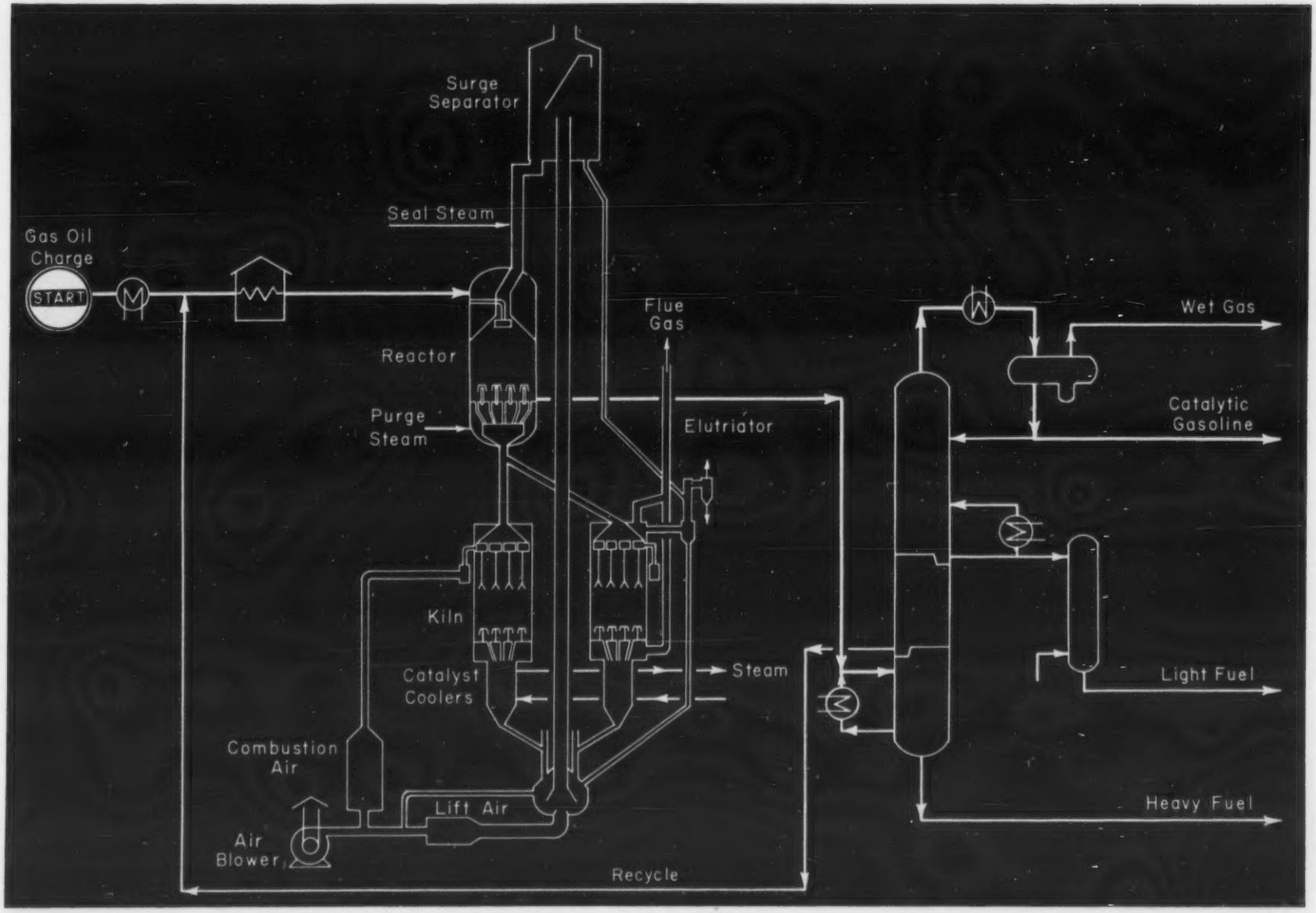
Economics: Investments costs are $120-300 per barrel from 5,000-40,000 barrels per stream day (excluding gas concentration facilities). Typical utility and chemical consumptions are shown below:

Item	Per Bbl. Feed
Steam (net production)	128 Lbs.
Power	2.2 KWH
Water	390 Gallons
Fuel	0.14 MM BTU
Catalyst	0.10 Lbs.

Annual maintenance materials and supplies are approximately 1.5% of investment, and maintenance labor not more than 1.8 yearly manhours per barrels per day feed.

Commercial Installations: At the present time there are 49 Airlift TCC units in operation; 29 in the U. S. and 20 in foreign countries. These units range from 1,600 barrels per day to 30,000 barrels per day in fresh feed capacity, and from 1,600 to over 30,000 pounds per hour in carbon burning capacity. The total throughput capacity of operating Airlift TCC units is well over 700,000 barrels per day.

Reference: Petroleum Refiner, vol 31, no 8, p 71 (Aug, 1952).


Surge Separator
Seal Steam
Gas Oil Charge
START
Flue Gas
Wet Gas
Reactor
Catalytic Gasoline
Purge Steam
Elutriator
Kiln
Steam
Catalyst Coolers
Light Fuel
Combustion Air
Lift Air
Heavy Fuel
Air Blower
Recycle

Fluid Catalytic Cracking—UNIVERSAL OIL PRODUCTS COMPANY

Application: To convert distillate oils into high octane gasoline and to reduce the overall refinery fuel oil production. Current designs are noted for simplicity, ease of operation and low operating and investment costs.

Charge: A wide variety of stocks from all types of crudes. Typical feeds may be either virgin or cracked and include naphtha, kerosine, light gas oils, wax distillates, atmospheric and vacuum gas oils and distillates from vis-breaking and coking. Feeds may be high in nitrogen and sulfur compounds and, in some cases, may includes some desalted crude.

Description: A typical flow diagram for a 5,000 bpsd unit is shown, featuring reactor and regenerator in a single vessel. The gas oil feed, cold or hot, is charged together with recycle into the hot regenerated catalyst stream, is vaporized, and passes to the reactor. Vapors from the reactor, carrying some catalyst, pass upward through the reactor cyclone separator, which removes most of the entrained catalyst, and into the fractionating column.

The spent, or used, catalyst passes downward from the reactor through the steam stripper and enters the regenerator where the carbon deposit is burned off. Oxygen for combustion is supplied by air from the air blower. The flue gases carrying some catalyst pass upward through the regenerator cyclone separators where entrained catalyst is removed, and pressure is released in a pressure reducing chamber which serves as a noise eliminator. The regenerated catalyst again enters the incoming gas oil charge stream to repeat the cycle.

An external feed preheater is optional. The initial heat to bring the unit on stream is supplied by a direct-fired air preheater and torch oil in the regenerator.

The fractionating column is of standard UOP design, with gasoline taken overhead and one or more selected fractions withdrawn as sidecuts. The net column bottoms are sent to storage via the slurry settler. Steam may be generated by recovery of heat in the fractionator column bottoms. Catalyst-containing oil from the bottom of the slurry settler is returned to the reactor with the fresh feed.

The unstabilized gasoline and gas pass to a gas fractionation section for debutanization and recovery of C_3—C_4 polymerization unit feed.

The UOP regenerator design utilizes pressure to increase the coke-burning rate, which permits a smaller sized regenerator and correspondingly less catalyst inventory. The catalyst inventory of a 5,000 bpsd unit with a coke burning capacity of 4,233 pounds per hour at 53 percent conversion (gas oil disappearance) is approximately 37 long tons. Catalyst loss at 53 percent conversion will not exceed 0.25 pound per barrel of fresh feed; at 70 percent conversion, loss will not exceed 0.40 pound. This is approximately equivalent to desirable make-up rates in maintaining constant catalyst activity. Actual catalyst consumption in many commercial units has been reported in the range of 0.1 to 0.2 pounds per barrel of fresh feed.

It has been found advantageous to subject high sulfur feeds to Unifining before charging to catalytic cracking, especially if a part of the feed is derived from certain types of coking operations. Not only is the sulfur greatly reduced, but heavy metals contents are substantially lower. There also is considerable evidence that the cracked product distribution is benefited. Alternatively to Unifining feed, certain cracking units can benefit from Unifining the gas oil recycle. The most apparent benefits in operation are a reduction in coke make and a small increase in the yield of desirable products.

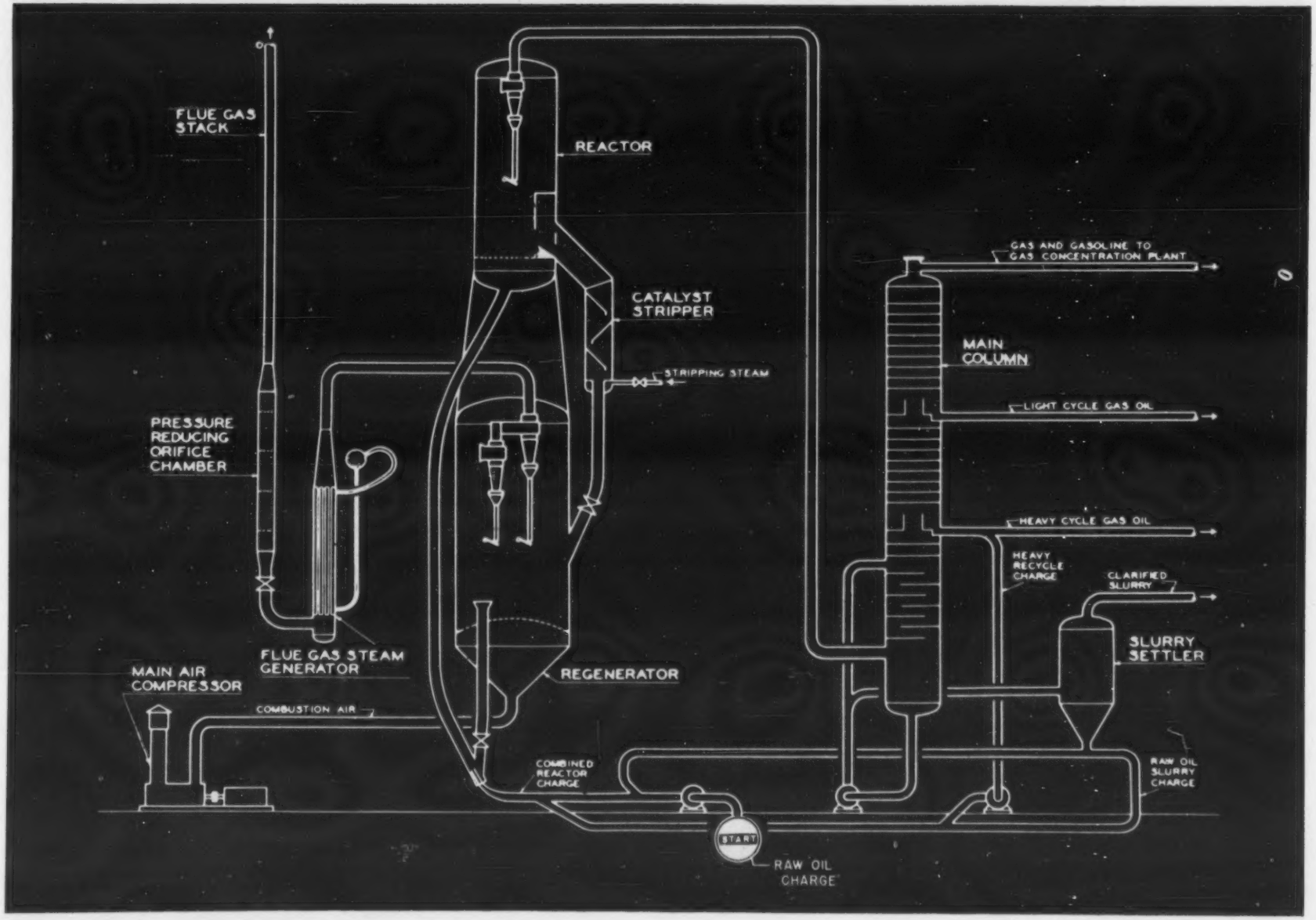
The design of this unit imparts particular flexibility. The unit can handle a rather wide range of catalyst-to-oil ratios to suit individual process requirements. It can process a totally liquid feed, provision is made to change reactor space velocity at will, reactor temperature can be varied over a wide range and a high octane product is produced. Moreover, installation and operating costs are low. Approximately 90 percent of the heat generated by burning off the catalyst is recovered in maintaining reactor temperature and by steam generation.

Yields: Typical yields when cracking a 28° API Mid-Continent gas oil in once-through and a recycle operations are given in the table.

Commercial Installations: UOP-designed fluid cracking units in operation or under construction range in size from 1200 to approximately 35,000 bpsd of fresh feed.

Reference: PETROLEUM REFINER, vol 30, no 3, p 130 (Mar, 1951).

OPERATION	Once Through	Recycle
Conversion	60	75
Yields (Volume Percent):		
Debutanized Gasoline	45.2	53.5
Light Cyle Oil	28	21
Heavy Cycle Oil	12	4
Butlyenes	5.9	8
Butanes	6.4	8
Propylene	5.0	6.4
Propane	2.9	3.7
C_2 and Lighter Gas, Wt. Percent	2.2	2.8
Octanes, 10-Psi RVP Gasoline:		
F-2 O.N. Clear	81.5	81.5
+ 3 cc. TEL	86.5	86.5
F-1 O.N. Clear	93.5	93.5
+ 3 cc. TEL	98.5	98.5
Yields with Polymerization (Volume Percent):		
10 Psi RVP Polymer Gasoline	7.6	10.0
10 Psi RVP Catalytic Cracked Gasoline	47.6	56.4
Total Psi RVP Gasoline	55.2	66.4


FLUE GAS STACK
REACTOR
GAS AND GASOLINE TO GAS CONCENTRATION PLANT
CATALYST STRIPPER
MAIN COLUMN
STRIPPING STEAM
PRESSURE REDUCING ORIFICE CHAMBER
LIGHT CYCLE GAS OIL
HEAVY CYCLE GAS OIL
HEAVY RECYCLE CHARGE
CLARIFIED SLURRY
SLURRY SETTLER
FLUE GAS STEAM GENERATOR
REGENERATOR
MAIN AIR COMPRESSOR
COMBUSTION AIR
COMBINED REACTOR CHARGE
RAW OIL SLURRY CHARGE
START
RAW OIL CHARGE

Fluid Catalytic Cracking, Model IV—

ESSO RESEARCH AND ENGINEERING COMPANY

Application: Converts gas oils and deasphalted stocks to high octane motor gasoline and other distillate products. The process also gives good yields of isobutane and light olefins which can be used for alkylation, polymerization, synthetic rubber, and chemicals manufacture.

Charge: A wide variety of virgin and cracked feed stocks, ranging from light distillates to vacuum distilled gas oils and deasphalted oils. By varying feed stocks to meet changing market conditions, refiners can approach the optimum utilization of their crudes at all times.

Product: High yields of motor gasoline with clear octane number of 80 to 85 Motor and 92 to 99 Research. Isobutane and light olefins for alkylation, polymerization, LPG, or synthetic rubber may be recovered.

Description: In Model IV Fluid Catalytic Cracking, reactor and regenerator vessels are mounted side by side at a low elevation. This alignment eliminates expansion and rotation joints, and results in minimum over-all height. As a result, structural steel and foundation costs are lower and mechanical construction is greatly simplified.

As shown in the drawing, catalyst is transferred from vessel to vessel at moderate velocities by means of U-bends. Slide valves for catalyst flow control are eliminated in the Model IV, thus further reducing over-all height. Elimination of these slide valves also contributes to longer allowable run lengths by removing a principal point of erosion. In place of slide valve control, a portion of the regeneration air is injected at varying rates into the riser of the spent catalyst U-bend. These changes in air rate vary the density in the riser, and thus cause changes in the flow rate between vessels. Catalyst circulation rates as high as 70 tons per minute have been achieved. Ability to circulate at such high rates permits the construction of heat-balanced units even in very large sizes.

The U-bend transfer system has proved to be very stable in periods of refinery upset. The catalyst in the U-bend not only acts as a seal between the vessels during normal operation, but also impedes reverse flow through these lines in the event of pressure surges. Model IV units return to stable operation as soon as pressures have been restored to normal levels.

A slide valve is provided in each U-bend to permit positive shutoff in case of emergency or serious upset. Since these slide valves are normally out of the path of flowing catalyst, they suffer no erosion, and assure a positive safe shutoff should it become necessary to isolate the vessels.

All of the spent catalyst, along with that part of the air used to control circulation, enters the regenerator through the spent catalyst riser. The remainder of the air necessary for combustion enters the regenerator through a grid. Because only cool air—and no catalyst—flows through the grid, it is possible to use a carbon steel grid and have no concern about erosion or warpage.

There are no inaccessible moving parts in a Model IV Cat Cracker. In fact, there are no moving parts at all, except the air blower, the feed pumps, and, of course, the pumps and gas compressor in the product recovery section. This absence of moving parts in locations of critical wear contributes to low maintenance costs and short turnaround times.

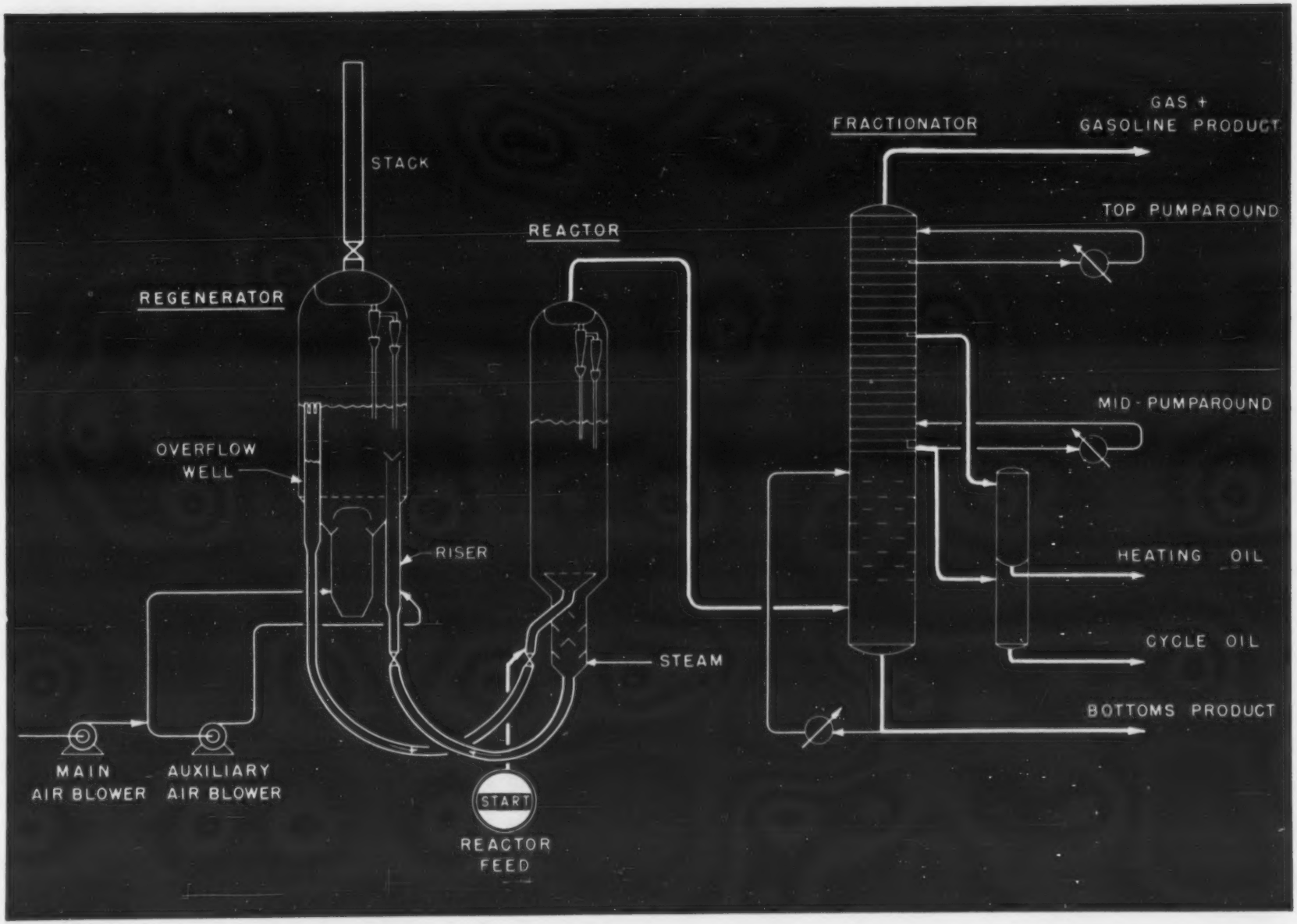
Commercial Installations: The first commercial unit, which went on stream in November, 1952, was a 15,000 bpd unit licensed to the Pan-Am Southern Corporation. Since that time the total Model IV capacity (approved, building or on stream) has increased to about 700,000 bpd, with over half of this capacity under license. These units, ranging in size from 4,880 to 55,000 bpd total feed (3,000 to 40,000 bpd fresh feed), are listed below.

Reference: PETROLEUM REFINER, vol 35, no 4, p 201 (Apr, 1956).

MODEL IV FLUID CATALYTIC CRACKING UNITS
(Operating, Building or Planned)

COMPANY	Location	Capacity, B/SD	Date on Stream	Contractor
Imperial Oil Limited...	Edmonton, Alberta	11,000	Dec., '52	Foster Wheeler
Imperial Oil Limited...	Sarnia, Ontario	25,000	Mar., '53	M. W. Kellogg
Esso Std. Soc. An. Fr.*	Port Jerome, France	15,400	July, '53	Foster Wheeler
Esso Std. Ref. Soc. An.*	Antwerp, Belgium	9,360	July, '53	Lummus
Esso Std. Oil Co.*.....	Everett, Mass.	24,000	July, '53	Foster Wheeler
Imperial Oil Limited...	Ioco, British Columbia	12,600	Nov., '53	Bechtel
Esso A. G.*.....	Hamburg, Germany	9,360	Dec., '53	Gutehoffnung-huette, A. G.
Std.-Vacuum Oil Co....	Durban, South Africa	9,740	Jan., '54	Foster Wheeler
Imperial Oil Limited...	Regina, Saskatchewan	13,600	May, '54	Fluor
Std.-Vacuum Oil Co.*..	Bombay, India	9,360	July, '54	Lummus
Empresa Col. de Pet....	Barrancabermeja, Col.	19,280	Sept., '54	Foster Wheeler
Imperial Oil Limited...	Halifax, Nova Scotia	27,000	Aug., '56	Foster Wheeler
Std.-Vacuum Oil Co.*..	Wakayama, Japan	20,000	Dec., '56	Refinery
Esso Std. Soc. An. Fr.*.	Port Jerome, France	23,150	Aug., '57	Refinery
Std.-Vacuum Oil Co....	Palembang, Sumatra	22,500	Aug., '57	Foster Wheeler
Int. Petroleum (Colombia), Ltd.....	Cartagena, Colombia	25,000	Oct., '57	Bechtel
Esso Std. Oil S. A.....	Belot, Cuba	24,000	Mar., '58	Arthur G. McKee
Esso S. A. P. A.....	Campana, Argentine	16,050	(1959)	.....
Total for Standard Oil Co. (N.J.) Affiliates	.....	316,400		
American Oil Co.....	Destrehan, La.	15,000	Nov., '52	Lummus
Cie. Francaise de Raff.*	La Mede, France	14,740	July, '53	Lummus
International Ref., Inc..	Wrenshall, Minn.	4,880	Aug., '53	Lummus
Lion Oil Company.....	El Dorado, Ark.	10,800	Dec., '53	Lummus
American Oil Co.....	Texas City, Texas	30,000	Jan., '54	Lummus
Std. Oil Co. of Calif....	El Segundo, Calif.	55,000	Sept., '54	Fluor
Calif. Texas Oil Co. Ltd.	Batangas, P. I.	10,800	Oct., '54	Foster Wheeler
Calif. Texas Oil Co. Ltd.	Yokohama, Japan	10,800	Dec., '54	Arthur G. McKee
Std. Oil Co. of B. C. Ltd.	Vancouver, B. C.	6,000	Dec., '54	Fluor
Salt Lake Ref. Co....	Salt Lake City, Utah	6,000	Aug. '55	Fluor
Calif. Texas Oil Co. Ltd.	Kurnell, Australia	30,000	Dec., '55	Foster Wheeler
Cie. Francaise de Raff..	Le Havre, France	30,000	June, '56	M. W. Kellogg
Calif. Texas Oil Co. Ltd.	Visakhapatnam, India	14,700	July, '57	Foster Wheeler
Std. Oil Co. of Texas...	El Paso, Texas	30,000	Aug. '57	Fluor
Petroleos Mexicanos....	Atzcapotsalco, Mexico	25,000	(1958)	Arthur G. McKee
Std. Oil Co. of Calif....	Richmond, Calif.	55,000	(1959)	Fluor
Irving Refining Co. Ltd.	St. John's, New Brunswick	13,300	(1960)	Bechtel
Std. Oil Co. of Calif....	Honolulu, T. H.	22,000	(1960)	Bechtel
Total Non-Jersey..	.....	384,020		
Grand Total.....	.....	700,420		

* Combination Unit.


STACK
REACTOR
FRACTIONATOR
GAS +
GASOLINE PRODUCT
TOP PUMPAROUND
REGENERATOR
MID - PUMPAROUND
OVERFLOW
WELL
RISER
HEATING OIL
CYCLE OIL
STEAM
BOTTOMS PRODUCT
MAIN
AIR BLOWER
AUXILIARY
AIR BLOWER
START
REACTOR
FEED

Fluid Catalytic Cracking, Orthoflow—THE M. W. KELLOGG COMPANY

Application: For the selective conversion of petroleum fractions boiling above the saleable distillate range, to valuable light olefins, high-octane gasoline, and No. 2 fuel oil.

Charge: Atmospheric and vacuum gas oils, visbreaker and coker gas oils, decarbonized oil and, in certain cases, whole reduced crude.

Product: High-octaine gasoline (frequently split into light gasoline for premium and super-premium and heavy gasoline for regular blends), furnace or diesel oil blend stock, olefins and isobutane for alkylation, butane and dry gas.

Description: The Orthoflow design, developed and licensed by The M. W. Kellogg Company, provides straight-line flow of catalyst between the vessels, virtually eliminating erosion normally encountered in pipe bends.

The Orthoflow principle has been developed in two alternative forms, both in successful commercial operation. In one system (A) the regenerator is located beneath the reactor and in the other (B) it is positioned above the reactor. Both systems have economic applications, the choice depending upon local cost factors. Both realize a unique degree of simplicity of construction, operation and maintenance.

A simplified flow diagram of the Orthoflow (B) Fluid catalytic cracking process is shown on the opposite page.

Fresh gas oil feed and recycle from the fractionator enter the base of the reactor through a distribution system. Hot regenerated catalyst flows downward through standpipes, contacts the oil vapors, and is carried up into the reaction zone in sufficient quantity to maintain the reaction temperature. A catalyst bed level is established in the reactor to give the required space velocity. Oil vapors from the cracking reaction are separated from entrained catalyst in internal cyclones and carried to the fractionator.

The spent catalyst stripping zone is positioned centrally within the reactor. Stripped spent catalyst is conveyed upward to the regenerator section with a portion of the regeneration air, which is admitted through the hollow stem of the spent catalyst plug valve. In the regenerator the spent catalyst is contacted with additional air to reduce the carbon content to the desired level. Internal cyclones are used to separate regenerated catalyst from the flue gas stream leaving the top of the regenerator.

In the fractionator, the reactor effluent is separated into gasoline, light gas oil, a recycle stream, and a slurry stream. The recovery consists of absorption and distillation towers to produce gasoline fractions as required and olefinic feed stock for catalytic polymerization or alkylation.

Through the construction of the reactor and the regenerator in a single vessel and the use of straight internal catalyst carrier lines, the Orthoflow represents the simplest design to date. One of the major design achievements was the development of plug valves which regulate internal catalyst flow. These valves eliminate the need for expansion joints in many instances and are more easily maintained than conventional slide valves. The operating history of Orthoflow units has been remarkably free of erosion difficulties. The rate of erosion of the plugs is considerably less than with slide valves and, unlike slide valves, the plugs inherently compensate for wear without loss of control.

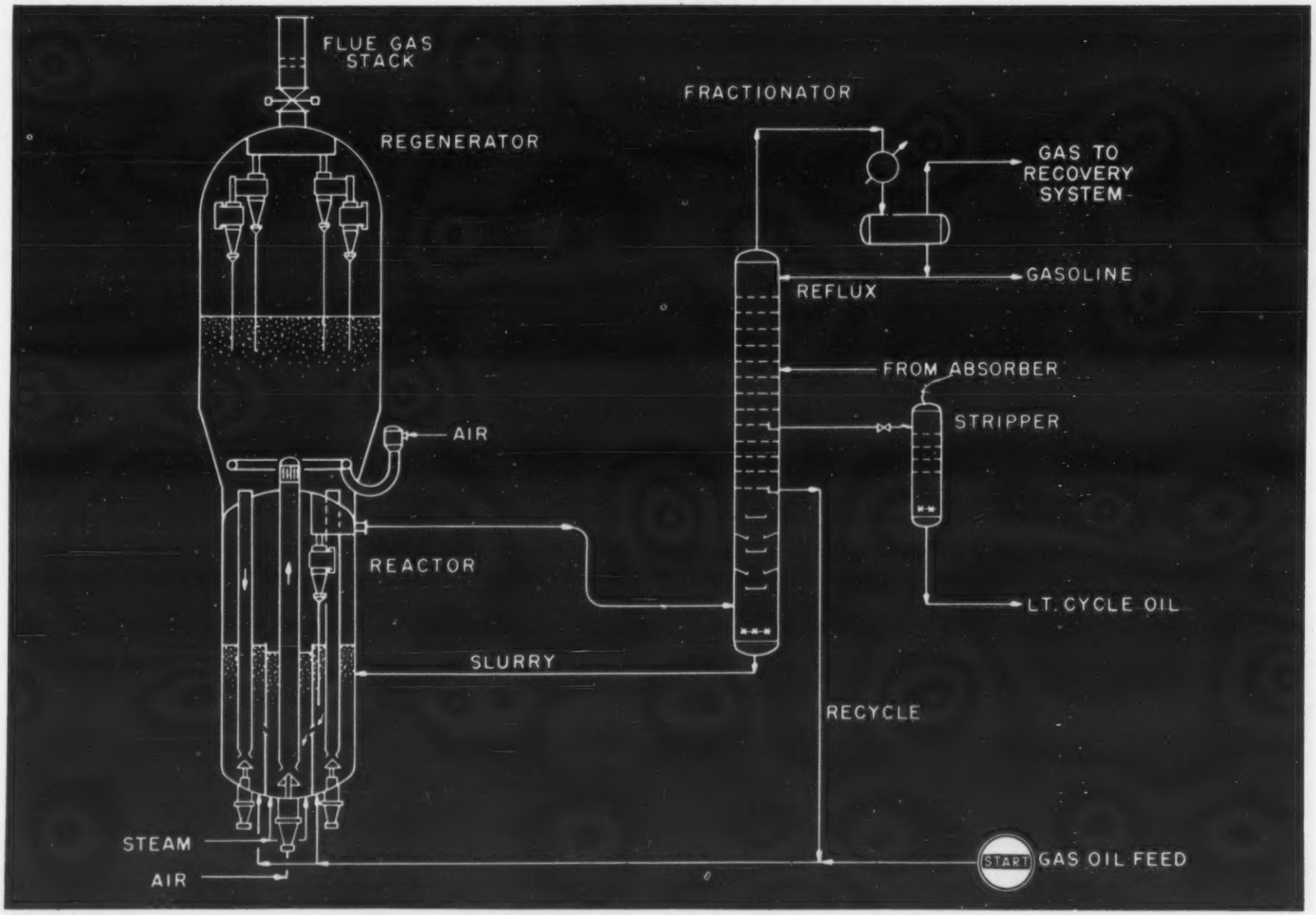
Operating Conditions:

Reactor Temperature	885-950 F.
Reactor Pressure	14-24 psig
Regenerator Temperature	1050-1150 F.
Regenerator Pressure	8-15 psig
Catalyst/Oil Ratio	7-12 C/O
Space Velocity	1.0-3.0 W/Hr./W.

Yields: Typical Yields from an Orthoflow F.C.C.U.

Charge Gravity, °A.P.I.	28.0
Throughput ratio	1.5
Conversion, volume percent	70.8
Tail gas, weight percent	7.8
C_3 to poly, weight percent	6.9
C_4 + gasoline, volume percent	58.0
Light cycle oil (No. 2 fuel), volume percent	23.5
Debutanized gasoline:	
Gravity, °A.P.I.	58.0
R.V.P., psi	7.0
50 percent point, °F	210
End Point, °F	420
F-1 O.N., Clear	93
F-1 O.N., + 3cc TEL/Gal.	99

Commercial Installations: At present 21 units of the Orthoflow design are operating or in various stages of completion. This number represents a total throughput capactiy of 485,000 barrels per day.


FLUE GAS STACK
REGENERATOR
FRACTIONATOR
GAS TO RECOVERY SYSTEM
GASOLINE
REFLUX
FROM ABSORBER
STRIPPER
AIR
REACTOR
LT. CYCLE OIL
SLURRY
RECYCLE
STEAM
AIR
START
GAS OIL FEED

Fluid Catalytic Cracking, Two Stage—SHELL DEVELOPMENT COMPANY

Application: For providing higher gasoline and lower coke yields while permitting greater flexibility for shifting production between maximum gasoline and maximum intermediates.

Charge: Conventional catalytic cracking feed stocks.

Products: Conventional, but with different distribution.

Description: The flow pattern for the process is shown in the accompanying diagram. The feed and hot regenerated catalyst travel concurrently up through a riser. This riser comprises the first-stage reactor in which the retention time is very short. The material from the riser passes into a high-load separator where the partially spent catalyst is removed from the products of the first stage cracking. The latter are sent to a fractionator to remove products that would be destroyed or adversely affected by subsequent cracking.

The unconverted and insufficiently converted hydrocarbons are removed from the fractionator as bottoms and sent to the second-stage reactor. Here the partially spent catalyst again contacts the hydrocarbons and additional cracking is achieved. The vapor from the second-stage cracking is separated by fractionation into the various boiling range products. The spent catalyst is passed to a regenerator and then recycled back to the first-stage reactor riser.

The Two-Stage Fluid Catalytic Cracking process is used to achieve optimum yields from various feed stocks. When cracking is carried out in one stage the least refractory components are cracked too severely and yield large amounts of gas and coke while the more refractory components undergo only low conversion. This overcracking and undercracking prevents the realization of optimum yields.

The first-stage reactor is operated at high temperatures so that the coke yields are kept low. This condition would have the disadvantage of destructively cracking some of the gasoline components of the charge, if it were not for the very short retention time. By sending the materials from the first-stage reactor to a fractionator, the material that might otherwise be overcracked can be removed from the cracking zones. The more refractory materials can then be given a longer, more thorough cracking in the second-stage reactor.

The catalyst for the second-stage operation is supplied from the first-stage separator. The partially used condition of this catalyst does not hamper the second-stage cracking.

In the two-stage cracking process, considerable flexibility is available for changing the yield structure from a given feed stock. For example, gasoline yield can be increased further by incorporating recycle into one of the cracking stages. On the other hand, in periods of high demand for intermediates, the yield of light gas oil may be increased substantially by charging only heavy gas oil to the second-stage reactor.

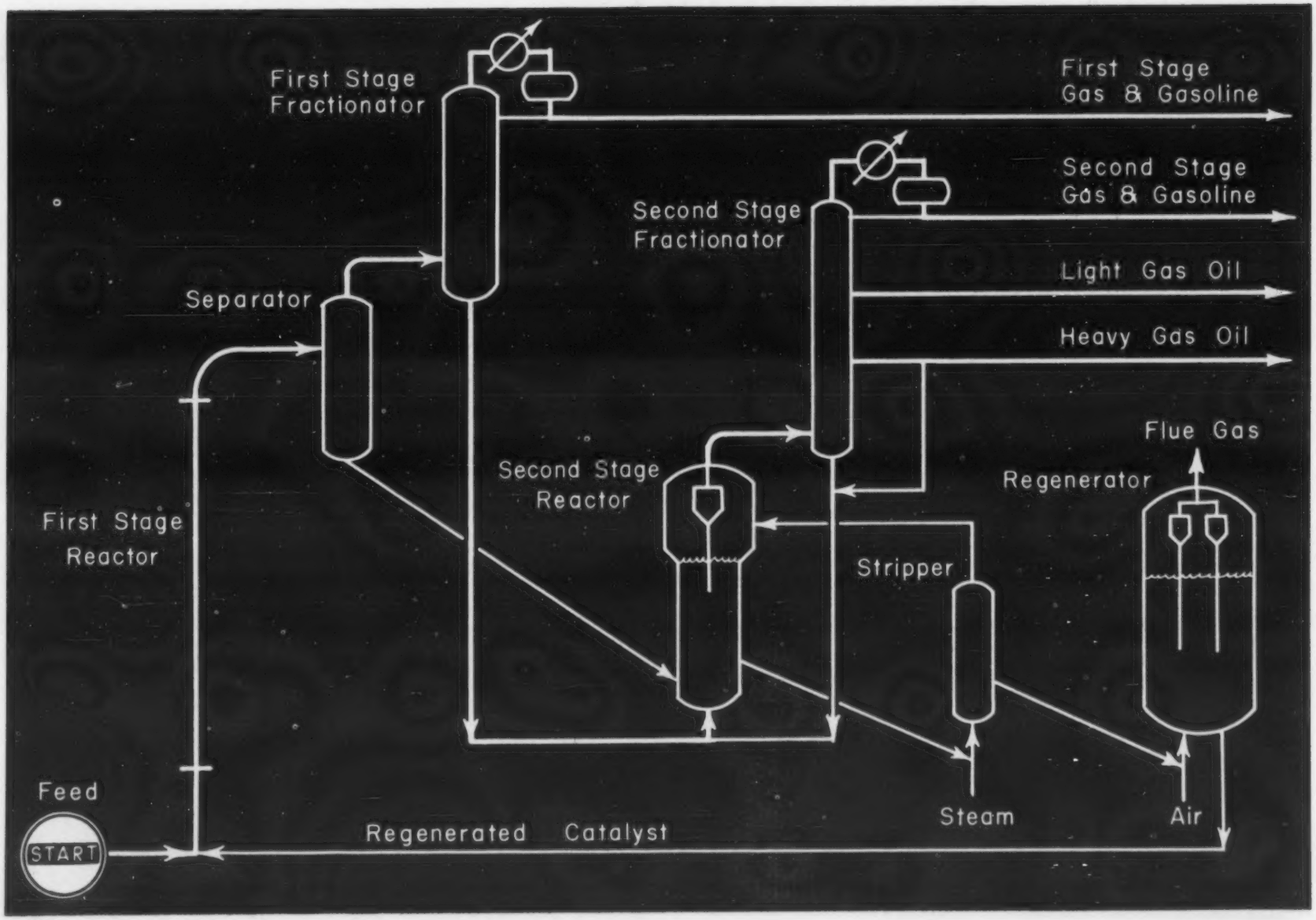
Application of the principles described here is not limited to new installations. Existing fluid units can, in some instances, be modified to take advantage of the short-contact-time and the two-stage principles by addition of a riser reactor and accompanying facilities. In cases where high conversion is not required, a single-stage rise reactor unit may be designed to take advantage of the increased selectivity.

Yields: Commercial operation has been on a mixture of Alberta feeds. The following table gives the properties of the feed and the distribution of the resulting products.

Alberta Feed-Stock	
Gravity, °API	23.7
ASTM Distillation, Degrees Fahrenheit:	
IBP	508
10 percent by volume	620
Pour point, degrees fahrenheit	+85
Ramsbottom carbon residue, percent by weight	0.83
Sulfur, percent by weight	1.26
Viscosity SSU at 210 F	51
Product Distribution, Volume Percent Unless Shown:	
Ethane and lighter (std. cu. ft. per bbl.)	(340)
Propylene	8.0
Propane	4.5
Butylenes	12.7
Butanes	5.1
Debutanized gasoline	53.3
Light gas oil	12.2
Heavy gas oil	12.4
Coke, percent by weight	(6.5)
Conversion	75.4

Commercial Installations: The first commercial unit employing this new technique was built in Shell's refinery at Anacortes, Washington. This process is licensed by the Shell Development Company through Universal Oil Products and the M. W. Kellogg Company.

Reference: PETROLEUM REFINER, vol 35, no 5, p 166 (May, 1956).


First Stage
Fractionator
First Stage
Gas & Gasoline
Second Stage
Gas & Gasoline
Second Stage
Fractionator
Light Gas Oil
Heavy Gas Oil
Separator
Flue Gas
Regenerator
Second Stage
Reactor
First Stage
Reactor
Stripper
Feed
START
Regenerated Catalyst
Steam
Air

Houdriflow and Houdresid—HOUDRY PROCESS CORPORATION

Application: (Houdriflow) To produce high-octane motor and aviation fuels from a wide range of petroleum distillate fractions.

Charge: Liquid, vapor, or a mixture of both. At most of the plants the reactor feed is over 50 percent liquid, and in some cases is totally liquid. Feed may also consist entirely of accumulated cycle stock. Sweet and sour stocks, and any fractions of the crude boiling between naptha and penetration asphalt, are handled with equal ease.

Product: Excellent yields of motor gasolines with octane values ranging from 88-94 F-1 clear (95-99 with 3 cc. TEL), depending upon charge stock, operating temperature, and catalyst used in the individual unit.

Description: The Houdriflow process is distinguished for its (a) ease of operation under normal and emergency operating conditions, (b) low maintenance and operating cost, (c) high catalyst activity in conjunction with low catalyst make-up cost, and (d) flexibility as to charge stocks handled and conversion levels attained.

A pneumatic lift system recirculates regenerated catalyst, which may be either natural or synthetic. The pneumatic lift was introduced in 1948, and this system supplanted the bucket-elevator catalyst lift.

The entire Houdriflow unit may be constructed compactly on a ground area 40 by 60 feet. The integrated catalytic reactor and regenerating kiln, comprising a single vessel, and the hot catalyst storage vessel, are self-supporting. They are customarily positioned on opposite sides of a steel structure housing a stairway and supporting the catalyst lift and elutriator.

Operating Conditions: Normally within the following ranges: Temperature 850-950 F.; Pressure 9-10 psig; Space velocity 1.5-4 v/hr/v; and Catalyst-oil ratio 3-7.

Yields: Conversion above 90 percent has been achieved in commercial operation with relatively low coke deposit, using recycle ratios of 1 to 1 or slightly more. Where once-through cracking is preferred, 50-60 percent conversion is obtained:

Charge, BPSD:[1]	A	B	C
Virgin gas oil	5,810	4,460	4,750
First pass cat. gas oil	1,430	—	—
Recycle	—	2,200	5,700
Total	7,240	6,660	10,450
Conversion	49.7	68.9	90.8
Products:			
Gasoline,[2] Vol. %	40.8	53.7	67.8
Total Gas oil, Vol. %	50.3	31.1	9.2
C_3-C_4 recovered, Vol. %	16.1	18.6	25.0
Liquid recovery, Vol. %	107.2	103.4	102.0
Fuel gas, wt. %	3.8	5.8	7.3
Catalyst deposit, wt. %	5.2	5.4	9.0
Gasoline octanes:			
F-1 Clear	91.5	90.6	89.3
F-1 + 3 cc TEL	—	—	96.7
F-2 Clear	81.7	—	—

(1) Charge stocks are atmospheric plus vacuum gas oils from: (A) Texas pipe line crude, (B) Scurry crude, and (C) Hutchinson-Moore, County, West Texas, crude.
(2) Gasoline basis: 10 psi RVP and 380 F at 90 percent distilled.

Commercial Installations: In the U. S. and abroad 21 Houdriflow units have been licensed ranging in size from 3,650 bpsd to 27,000 bpsd design capacity.

Total nominal design capacity of all Houdriflow catalytic crackers in operation and under construction is 278,430 bpsd.

Reference: PETROLEUM REFINER, vol 31, no 5, p 133 (May, 1952).

Application: (Houdresid) To produce high-octane gasoline and light distillate fuels from reduced crudes.

Charge: Residuum cuts ranging from atmospheric tower bottoms to vacuum bottoms, or the entire crude, if desired. The Houdresid unit permits refineries great flexibility in the kind of crude that may be run. Residua high in sulfur and nitrogen may be charged. Novel process features prevent the adverse effects on product selectivity heretofore resulting when heavy metals, such as nickel and vanadium, are present in the feed.

Product: Exceptional yields of high-octane gasoline and light distillate fuels. Octane values of the gasoline are in the 90-95 F-1 clear range.

Description: The process and mechanical design of the Houdresid unit is based on information and equipment developed in the well-established Houdriflow cracking process. Oil, catalyst and air flows are similar to those in a Houdriflow unit. Catalytic reactor and regenerating kiln are integrated in a single vessel, and regenerated catalyst is recirculated by a pneumatic lift system. All units of the process may be compactly arranged on a ground area 40 by 60 feet.

Either natural or synthetic catalyst may be used; it has been demonstrated that an inexpensive natural catalyst is particularly well suited to Houdresid processing. It is not necessary to withdraw catalyst in order to maintain selectivity and activity.

Yields: Reduced crude from mixed Mid-Continent, Texas and Louisiana crudes processed in a commercial Houdresid unit attained conversion ranges of 65-70 volume percent, depending on changes in throughput, recycle ratio, space rate, temperature, and catalyst-oil ratio.

C_5+ gasoline yields varied from 48 to 53 volume percent, and coke (catalyst deposit) from 5.9 to 8.2 weight percent of charge.

The Houdresid process also provides greater potential polymer gasoline yield from polymerization of C_3-C_4 cuts for blending into final high octane product, as well as favorable proportions of No. 2 domestic fuel oil.

Heavy Residua

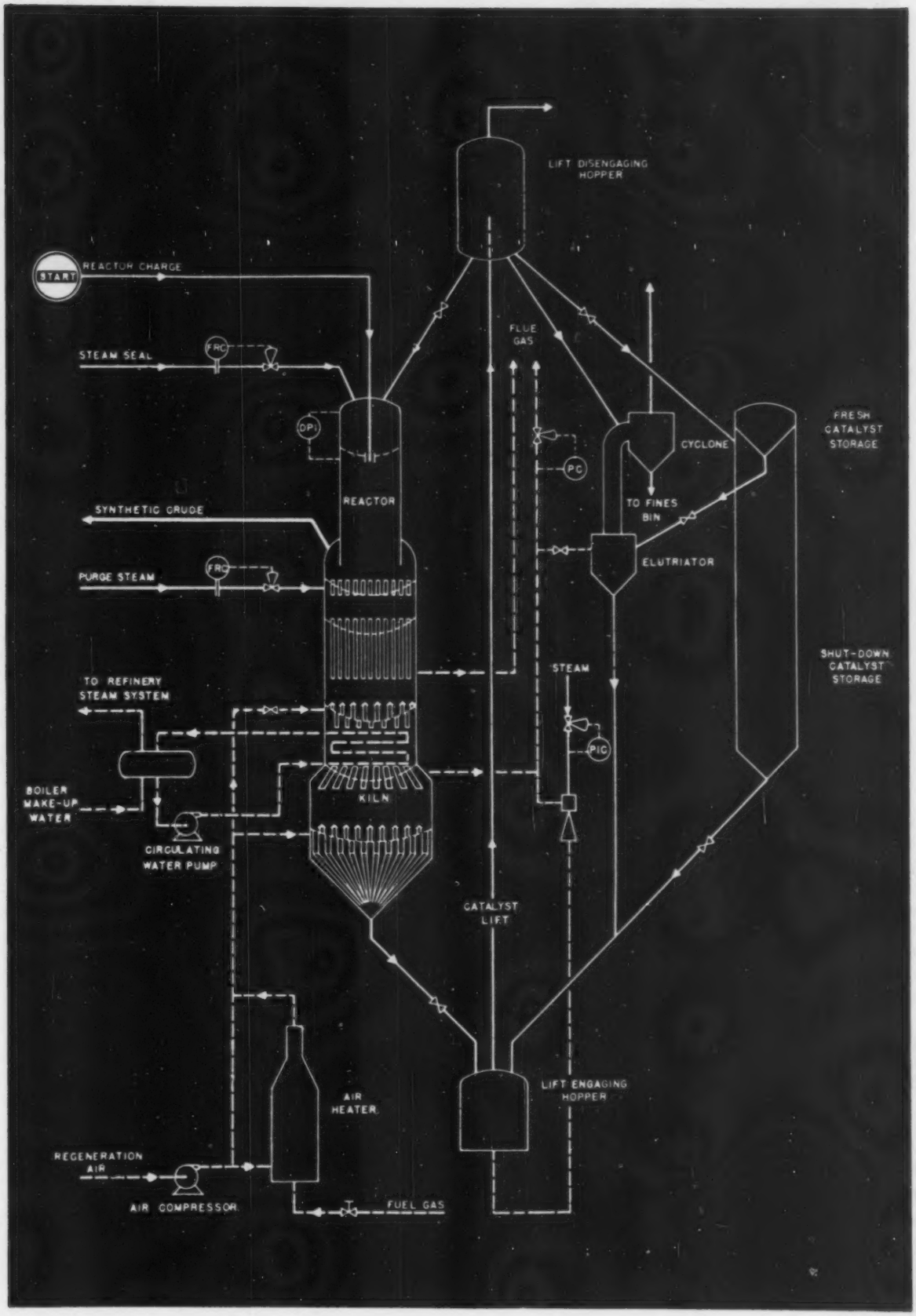
Charge:			
% Reduced Crude	10[1]	10.6[2]	4.1[2]
Gravity °API	12.6	17.7	12.7
Sulfur, wt %	0.91	0.72	1.02
Yields, based on fresh feed once through			
Debutanized Gasoline, vol %	40.1	42.6	40.4
Cat Gas Oil, vol %	40.2	37.0	27.1
C_4 Fraction, vol %	10.4	13.1	15.6
Dry gas, wt %	7.3	11.6	13.5
Coke, wt %	16.3	8.5	17.6
*C_5^+ Gasoline, F-1 Octane, clear	89.3	93.4	90.7

(1) South Central Texas Mixed Reduced Crude
(2) Mixed Mid-Continent, Texas, and Louisiana Reduced Crude

Mixed Mid-Continent, Texas, and Louisiana Crudes

Charge Rate, B/SD			
Reduced Crude	5,020		6,410
Recycle	2,340		3,600
Total	7,360		10,010
Charge			
Gravity, °API		26.9	
Sulfur, wt %		0.47	
Yields, based on fresh feed			
Conversion, vol %	67.6		67.6
Debutanized Gasoline, vol %	48.5		51.6
C_4 Fraction, vol %	14.8		13.1
Dry gas, wt %	10.3		7.9
Coke, wt %	7.1		5.9
Hydrogen, SCF/Bbl residium converted	129		138
C_5^+ Gasoline			
F-1 Octane, clear	93.0		91.6
Sulfur, wt %	0.08		0.08

Reference: PETROLEUM REFINER, vol 34, no 6, p 153 (June, 1955).


LIFT DISENGAGING HOPPER
START
REACTOR CHARGE
STEAM SEAL
FRC
FLUE GAS
DPI
PC
CYCLONE
FRESH CATALYST STORAGE
REACTOR
TO FINES BIN
SYNTHETIC CRUDE
ELUTRIATOR
PURGE STEAM
FRC
SHUT-DOWN CATALYST STORAGE
STEAM
TO REFINERY STEAM SYSTEM
PIC
KILN
BOILER MAKE-UP WATER
CIRCULATING WATER PUMP
CATALYST LIFT
LIFT ENGAGING HOPPER
AIR HEATER
REGENERATION AIR
AIR COMPRESSOR
FUEL GAS

Coking

Application: To prolong cracking conditions so that the yields of gas oil and gasoline are increased.

Charge: Reduced crudes, cracked tars, heavy catalytic cycle oils, and asphalts.

Products: Gas oil, gasoline, gas and coke.

Description: In the coking process the feed is heated and charged to the lower portion of a fractionator. Here the charge meets the hot vapors from the coking drum and the light components are flashed from the charge. Some installations use stripping steam to assure adequate removal of these light materials.

The heavy residue is taken from the bottom of the fractionator and passed through a furnace where it acquires the heat of cracking. The design of the furnace is such that a minimum of coke is layed down within the furnace coils. This is achieved by choosing the proper fluid velocity and heat transfer for the critical region within the furnace where coking is likely to occur.

The heated residue is introduced into an insulated drum where the residence time is sufficient for coke to form and settle from the mixture. The vapors from the coking operation leave the top of the drum and return to the fractionator. Here the gas, gasoline, and gas oil products are separated and sent to storage or to subsequent processing units. The heavier products appear in the bottom of the fractionator and are recycled to the coking operation.

Most units have a side stream cooler or reflux system on the fractionating tower where some of the heat is used for steam generation. Other units use this heat to preheat the process charge.

In the coke drums the coke continues to build up until a predetermined level is reached. The flow is then diverted to another drum which has been preheated so that the furnace operation may be continuous. The switching of flow from one drum to another must be made quickly to avoid coking within the transfer lines.

A full coke drum which has been removed from the process is steamed to strip light hydrocarbons from the coke. It is cooled by water injection and the head removed. The coke dumping operation is then begun.

In early designs the coke was removed with pick and shovel. A later method was to drill a hole up through the coke formation and use a chain and ball mechanism to beat out the coke. More recent designs use high pressure (over 1,000 psig) water jets to cut the coke from the drum.

In the past it was considered necessary to have at least three coke drums to sustain continuous operation because of the difficulties encountered during coke removal. Now, however, units are designed for two coke drums. For greater capacities the unit may have as many as four or six coke drums. Even so they are operated in pairs with one drum on-stream while the other is being dumped.

The coke drums are usually operated on a 48-hour cycle. Each drum is given 24 hours on-stream and 24 hours off-stream. This has the advantage of requiring only one dumping crew, and their work may be scheduled to occur only during the day shift.

Operating Conditions: The normal range of operating conditions for which coking units have been designed are as follows:

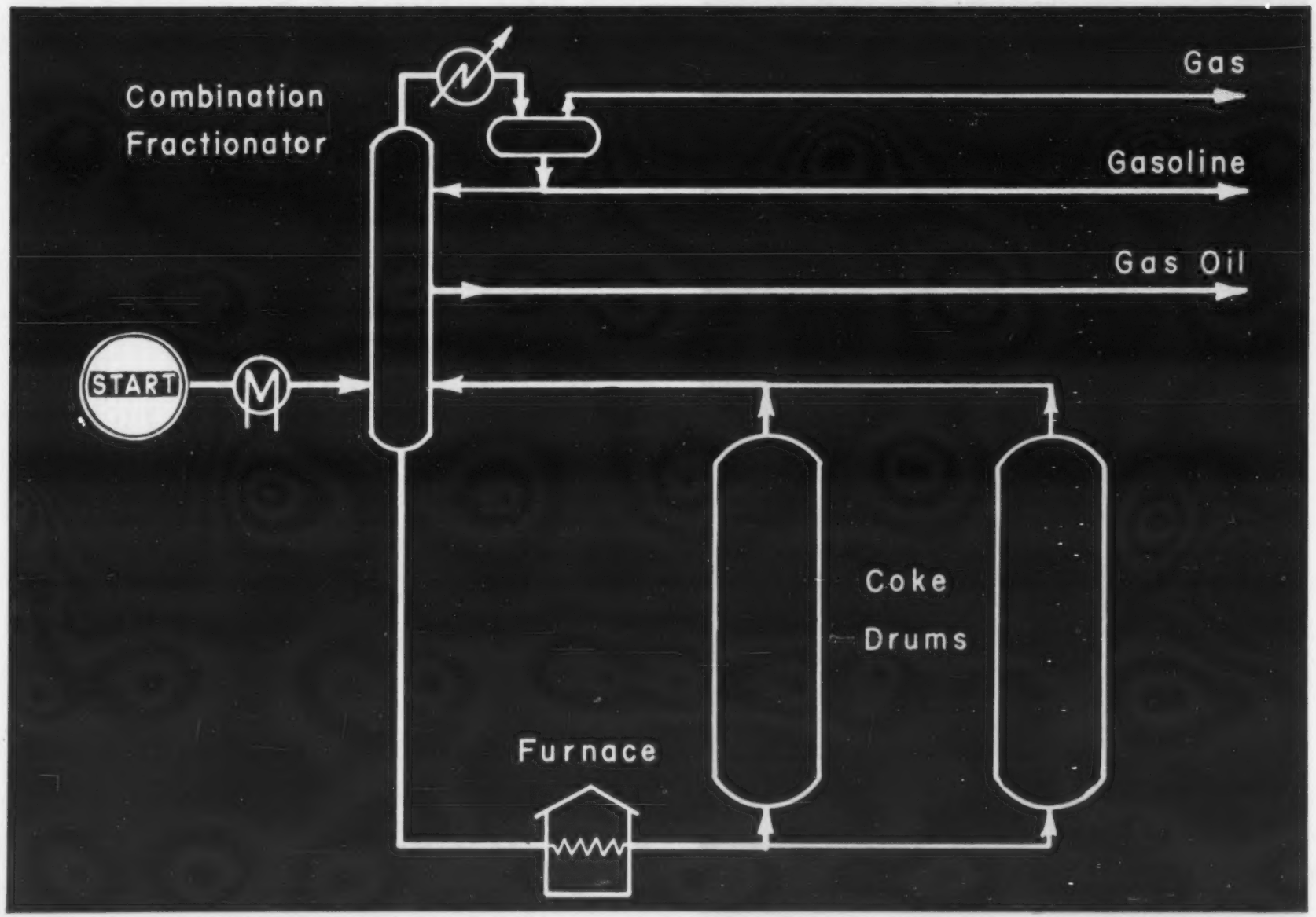
Furnace Outlet Temperature	900-940 F
Coke Drum Temperature	780-840 F
Coke Drum Pressure	10-70 psig

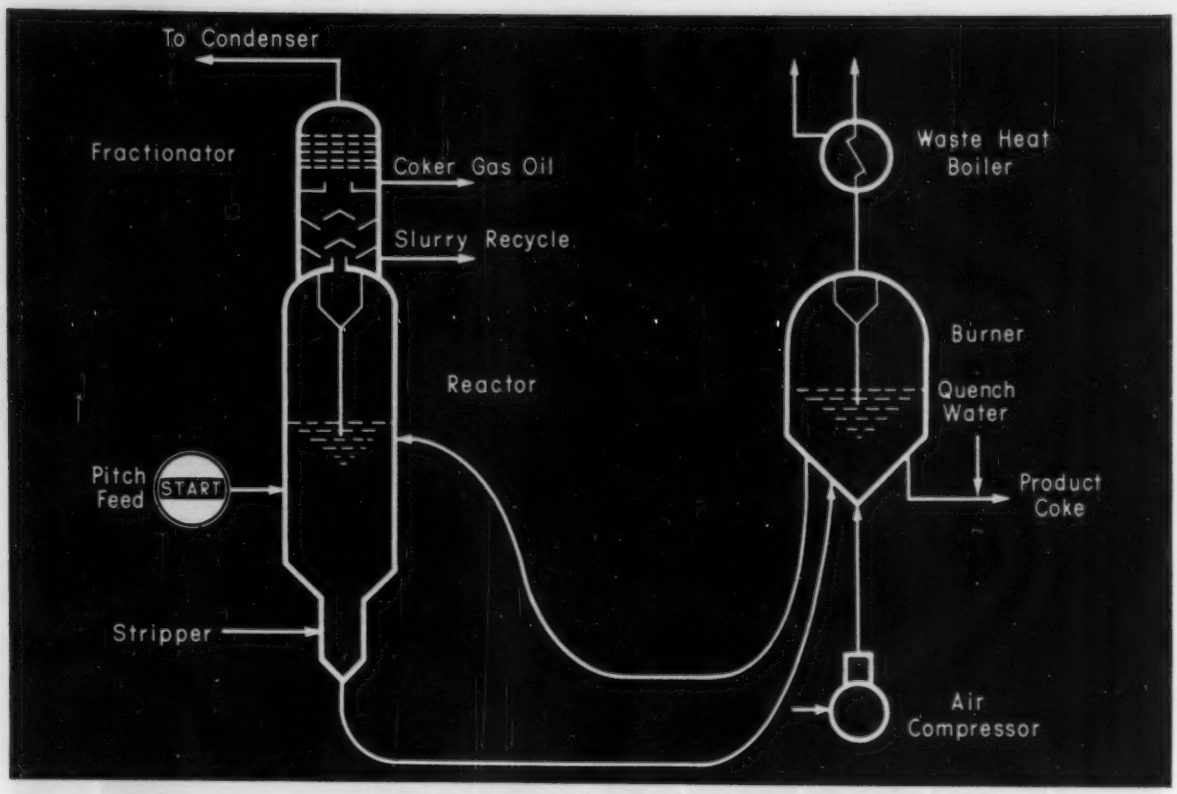
Yields: There is a wide variation in the product distribution from different coking units depending on whether gasoline is to be produced during the coking operation or during subsequent cracking of the coker gas oil. Gasoline yields may be from 5 to 25 volume percent of the charge to the coking unit.

Commercial Installations: In the U. S. and Canada there exists drum coking capacity to process about 470,000 barrels of feed per day. This is equivalent to about 15,500 tons of coke per day.

Reference: Coking units are designed and installed by several companies under various names. Process descriptions and yield data for most of these designs have been published in the PETROLEUM REFINER. Reference to these descriptions are given in the following table.

Name	Company	Reference: PETROLEUM REFINER
Decarbonizing	Blaw-Knox Company	Vol 32, No 7, p 106 (July, 1953)
Delayed Coking	Foster Wheeler Corporation	Vol 31, No 9, p 148 (September, 1952)
Delayed Coking	The M. W. Kellogg Company	Vol 32, No 7, p 108 (July, 1953)
Delayed Coking	The Lummus Company	Vol 32, No 7, p 102 (July, 1953)
Delayed Coking	Union Oil Company of California	Vol 34, No 7, p 149 (July, 1955)
Low Pressure Coking	Universal Oil Products Company	Vol 33, No 2, p 157 (February, 1954)


Combination
Fractionator
Gas
Gasoline
Gas Oil
START
M
Coke
Drums
Furnace



Fluid Coking—ESSO RESEARCH AND ENGINEERING COMPANY

Application: Upgrades a wide range of low-value residual stocks to gas oil, gasoline, and by-product gas and coke.

Charge: Atmospheric residua with initial boiling points as low as 600-700 F. or vacuum residua with initial points close to 1200 F. Feed stocks with gravities as low as —3.5°API and with Conradson Carbons as high as 41 percent have been processed. Indications are that any pumpable hydrocarbon feed can be handled by this flexible process without much change in equipment.

Product: Naphtha, gas oil, coke and light gases. Clear research octane number of the debutanized coker naphtha is 75 to 80, and it can be treated for satisfactory stability. As a cracking stock, coker gas oil is slightly poorer than virgin gas oil.

Description: The system is similar to that employed in Fluid Catalytic Cracking, but operates with somewhat coarser solids and employs no catalyst. Instead, small particles of petroleum coke, formed in the process itself, circulate in a fluid state between the vessels and act as a heat transfer medium.

Fluid coking requires no pre-heat furnace or elaborate mechanical equipment for handling coke in the process. The process operates at essentially atmospheric pressure and temperatures of 900 to 1050 F. Compared with other coking processes, Fluid Coking requires lower initial investment and costs less to operate.

The hot residuum feed is sprayed through nozzles into a bed of fluidized coke in the reactor as shown in the figure. The coking temperature may be in the range of 950-1050 F., but is very uniform throughout the bed with as little average variation as ±2 F. The bed is fluidized by the product vapors with the assistance of steam added at the bottom of the reactor.

In the reactor, the feed is converted to lighter products and coke which deposits itself on the particles in the fluidized bed. The vapor products are taken overhead through cyclone separators which remove most of the entrained coke and return it to the reaction zone.

The overhead product continues through a scrubber-fractionator tower where small amounts of heavy liquid product and coke dust are slurried from the scrubber back to the reactor. The product is then fractionated directly into a wide gas oil cut, which may be used for feed to Fluid Catalytic Cracking, and lighter distillate products.

A stream of coke is transferred like a fluid from the reactor through a stand-pipe-riser system to the burner where air is supplied to burn enough of the coke to provide heat for the process. If desired, another fuel such as low quality oil can be burned in the heater in preference to the coke product. The hot coke carries heat back to the reactor through a transfer line which completes the continuous circuit. The net coke produced is withdrawn to maintain the proper inventory within the system.

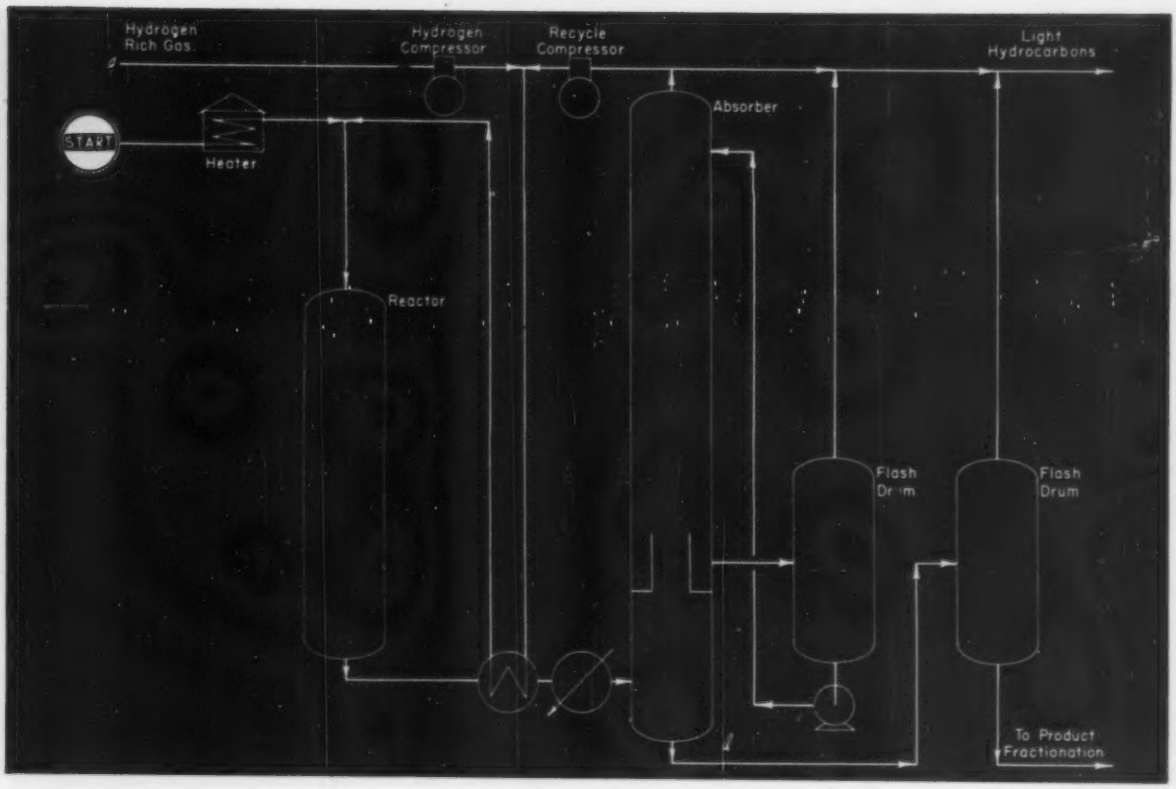
A unique grinding technique is employed in the reactor to maintain desired particle size in the system. The product coke is removed from the burner and quenched to a safe handling temperature by direct contact with water.

Yields: Fluid Coking makes less coke than conventional coking and results in improved yields of more valuable distillate products. The C_3 and C_4 cuts are normally 60-75 percent unsaturated and provide an attractive source of polymer feed.

Reference: PETROLEUM REFINER, vol 36, no 9, p 211 (Sept, 1957).

COMMERCIAL FLUID COKING UNITS

COMPANY	Location	Capacity, BPSD	Date on Stream	Contractor
Carter Oil Co.	Billings, Mont.	3,800	Dec. '54	Fluor
Esso Standard Oil Co.	Baltimore, Md.	10,000	Sept. '55	Bechtel
Canadian Petrofina, Ltd.	Montreal, Quebec	3,800	Aug. '56	Canadian Kellogg
Aurora Gasoline Co.	Detroit, Mich.	4,000	Oct. '56	R. M. Parsons
Tidewater Oil Co.	Associated, Calif.	42,000	Dec. '56	Bechtel
Tidewater Oil Co.	Delaware City, Del.	42,000	Feb. '57	C F Braun
Bankline Oil Co.	Bakersfield, Calif.	4,000	Apr. '57	Fluor
Pontiac Eastern Corp.	Hattiesburg, Miss.	4,800	Dec. '57	Fluor
Total		114,400		



H-Oil—HYDROCARBON RESEARCH, INCORPORATED

Application: Desulfurizes and upgrades all types of petroleum stocks, particularly heavy sour crudes and heavy residues.

Charge: All types of virgin and/or cracked stocks requiring desulfurization and upgrading. Whole crudes, residual stocks, or asphalt may be charged. Typical charge stocks and yields are as shown in the accompanying table.

Product: Light straight run distillates are almost completely desulfurized with essentially 100 volume percent yield. Heavier cracked distillates, sour crudes and heavy residual stocks are desulfurized to the extent of 75 to 90 percent and yields of 103-106 percent by volume are obtained depending on the type of charge stock. The synthetic crudes obtained from heavy sour residues are comparable to premium-priced sweet crudes.

Description: The accompanying simplified flow diagram shows the basic equipment included in a H-Oil unit processing high-sulfur residuum feed stock. Slight modifications in the diagram would be made if distillate stocks or whole crudes are to be treated. Referring to the diagram, the residuum feed is pumped to system pressure, heated in a fired heater and charged to the H-Oil reactor. Hydrogen make-up, compressed to system pressure, joins with recycle hydrogen and is preheated against reactor effluent before entering the reactor.

The oil charge undergoes: desulfurization, nitrogen removal, upgrading of residuum into valuable distillate fractions, stabilization by satisfying unsaturated chemical bonds and a small amount of hydrocracking. Various hydrogenation catalysts have been used in the "H-Oil" reactor depending on the particular feed stock and the distribution of end products that are desired. With an "H-Oil" reactor of special design which permits essentially isothermal operation, the catalyst consumption ranges from 20 to 80 barrels per pound depending on the type of feed stock. The high hydrogen partial pressure minimizes coke lay-down on the catalyst and permits long catalyst life even with heavy sour residues.

The reactor effluent is cooled by heat exchange and cooling water. After a vapor-liquid separation is made, the recycle vapor is scrubbed free of H_2S and inerts in a lean oil absorber. The recycle vapor, essentially hydrogen, is returned to the reactor by a recycle compressor.

The lean oil is flashed in a drum to free the circulating oil of the light hydrocarbon gases. The liquid product from the separator also flows to a flash drum to remove dissolved light gases. The liquid product from the low pressure drum flows either to storage or to a fractionator to be separated into the various liquid fractions.

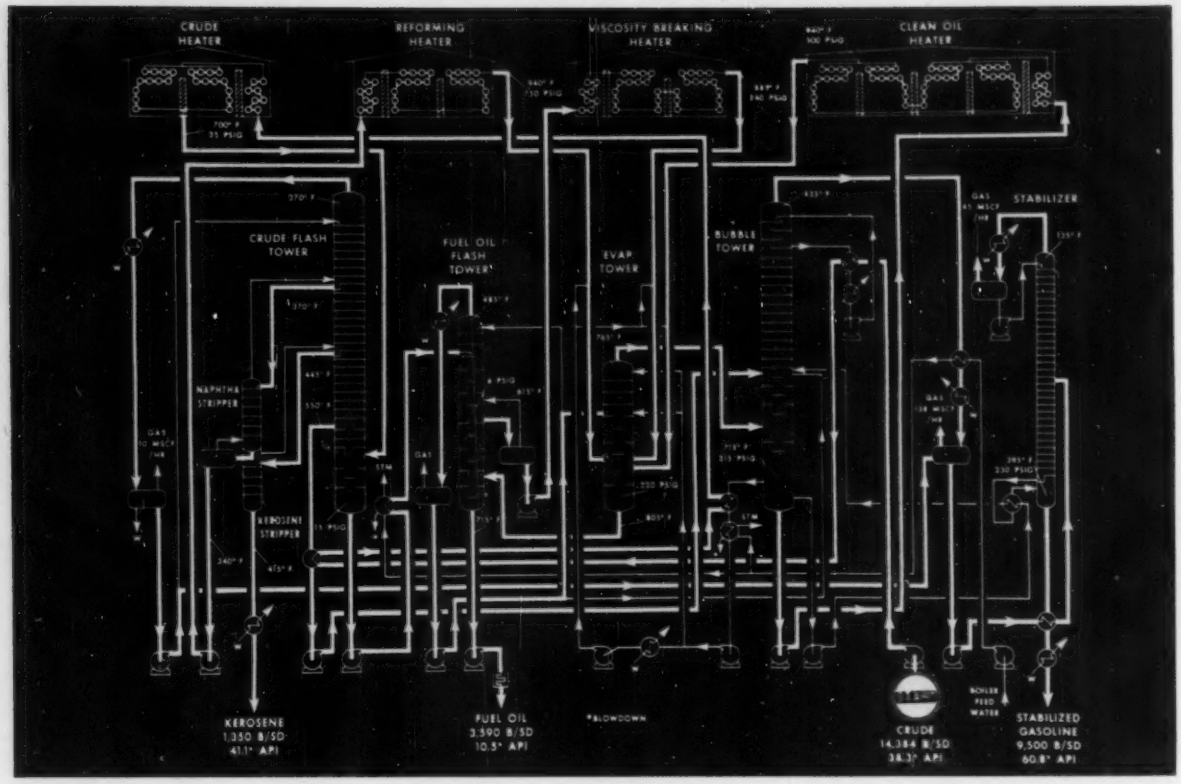
Yields: See reference for detailed data.

Operating Costs: See accompanying table.

Reference: PETROLEUM REFINER, vol 36, no 9, p 201 (Sept, 1957).

Typical Direct Operating Costs:
(5,000 bpsd-Unit)

Feedstock	Kuwait Residuum
Gravity, ° API	8.3
Sulfur, wt. %	5.3
C_4^+ Liquid Product	
Vol. %	104.8
Gravity, °API	26.9
Sulfur, wt. %	0.99
Operating Cost, ¢/bbl. Feed	
Power @ $0.008/KWH	1.4
Fuel @ $1.20/bbl.	2.0
Water @ 0.013/1000 gal.	1.1
"H-Oil" Catalyst	4.0
Labor @ $180/day	3.6
Supervision @ 30% labor	1.1
Total Direct Operating Cost, ¢/bbl. Feed	13.2



Combination Cracking—THE LUMMUS COMPANY

Application: For the segregation of cracking stocks and their independent selective cracking under optimum conditions.

Charge: Crude oil.

Product: Stabilized gasoline, fuel oil and kerosine.

Description: The accompanying process flow diagram is for a modern combination unit employing three cracking heaters, a crude heater, and a five tower fractionating system. This unit is designed to process 14,000 bpd of 38° API crude oil. The operating conditions for processing of this specific stock and the products obtained are shown on the diagram.

The crude charge is preheated to suitable temperature for distillation by heat exchange with cracking process streams and the crude heater. In the crude flash tower the kerosine is fractionated and the naphtha is removed for reforming. The topped crude less fuel oil is mildly cracked in a viscosity breaking step and the clean gas oil is thermally cracked.

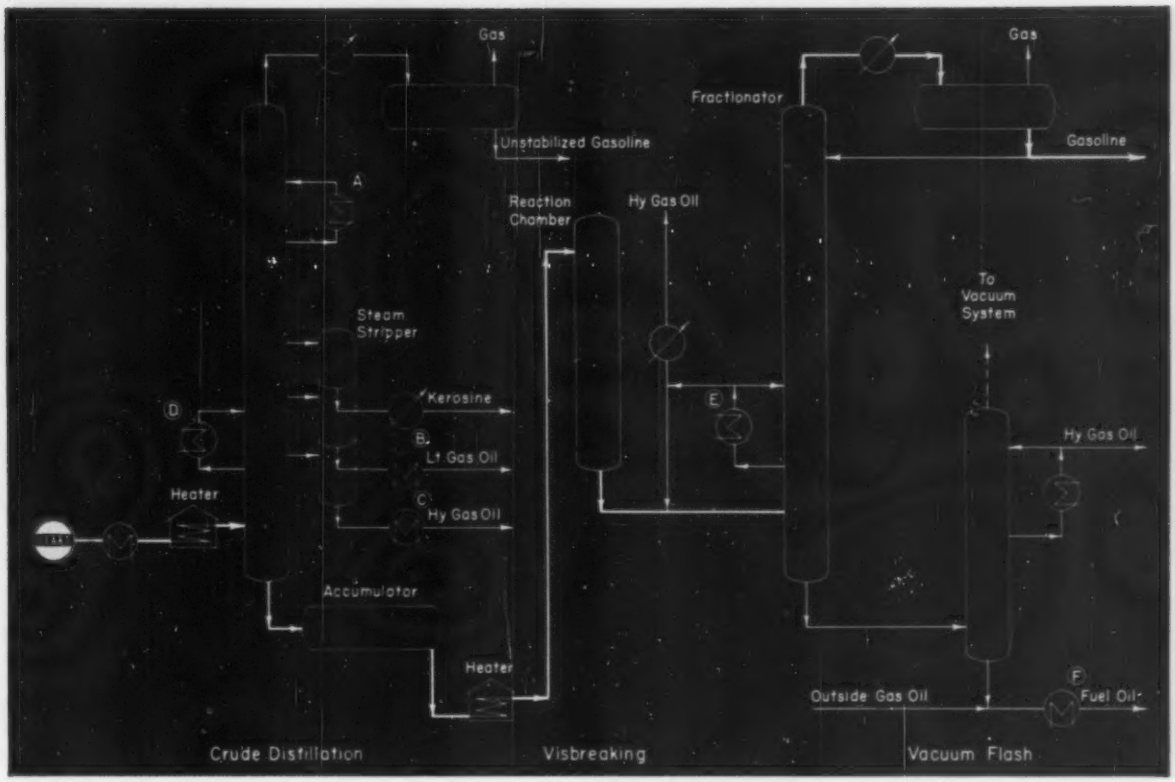
To design for optimum cracking conditions for each stock, independent control of the heating and soaking conditions must be provided. Hence cracking is made selective by employing several cracking coils, each having separately fired heating and soaking chambers in the furnace settings. Another factor which is considered in the heater design of these units to insure and provide an unusual degree of operating flexibility is a uniform rate of heat transfer which will maintain a satisfactory degree of temperature control resulting in minimum coke formation.

The flow sheet given shows one type of combination cracking. The design of such a unit varies with the specific needs of the refiner. However, each unit is basically designed for the segregation of cracking stocks and their independent selective cracking under optimum conditions. The segregation of cracking stocks is based according to both refractivity and boiling range. The selected stocks are cracked under closely controlled conditions in heaters of special design to obtain maximum conversion per pass larger yields and longer runs.

Modern development and improvement in catalytic cracking greatly reduced the application of thermal cracking processes in the refining of petroleum in the U. S. However, it still remains an excellent balance tool in processing catalytic cycle stock and an excess of heavy oils into additional production of gasoline. In countries where there is no race for high octane number gasolines, the thermal cracking processes are still in demand, particularly for combination units with topping, vis-breaking and gas oil cracking.

To illustrate the versatility of units of this nature, during the initial run of a four coil unit it was possible to switch from one crude oil to another of a different type, without interrupting the run or making any off specification products.

Commercial Installations: Twelve.



Combination Unit—FOSTER WHEELER CORPORATION

Application: Combines the operations of crude distillation, visbreaking, and vacuum flashing. The visbreaking process reduces the viscosity and pour point of the ultimate fuel oil product and provides additional feed stock for catalytic cracking.

Charge: Crude oil to the distillation unit, reduced crude to the visbreaking unit, and visbreaker heavy residual bottoms to the vacuum flash unit.

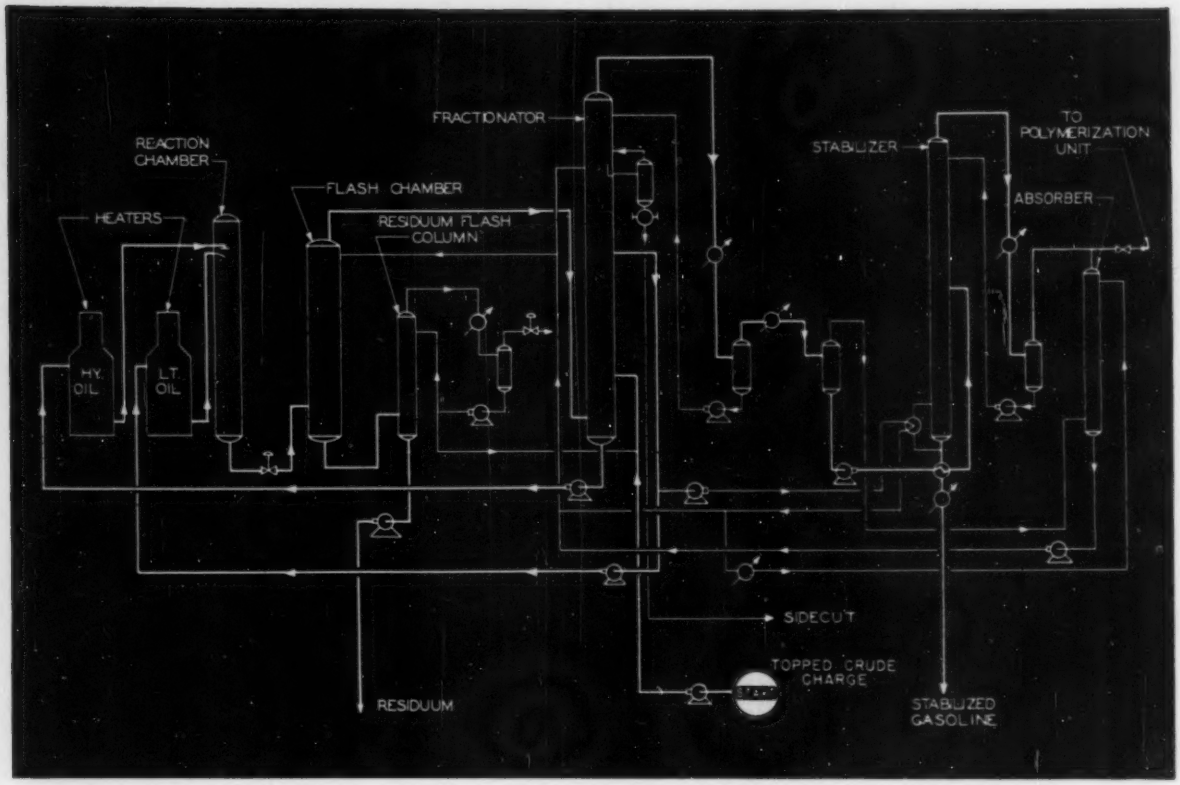
Products: From the crude unit, unstabilized gasoline, kerosine, light gas oil, heavy gas oil and reduced crude. From the visbreaking unit, gasoline, heavy gas oil, cracking stock, and a heavy residual as bottoms. From the vacuum flash unit, heavy gas oil and fuel oil.

Description: Referring to the flow diagram, the crude entering the combination unit is split into two streams. The first stream exchanges heat with the top-of-column pump-around of the crude distillation column (A). It then picks up additional heat by heat exchange with the light and heavy gas oil side streams from the crude distillation column (B & C). Further heat is added by heat exchange with the mid-pump-around of the crude distillation column (D). This crude stream then joins the other crude stream which has been preheated by exchange with the pump-around system of the visbreaker fractionator (E). The combined streams pick up more heat by heat exchange with the bottoms from the vacuum flash unit (F) and then flow directly to the direct-fired heater of the crude distillation unit. Part of this combined stream passes through the convection section of the direct-fired heater of the visbreaker unit and then flows to a lower pressure position in the direct-fired heater coil. The preheat temperature of the combined stream leaving the last heat exchanger is 495 F., while the temperature of the stream further preheated in the convection section is 640 F.

In the direct-fired heater of the crude distillation unit the crude is heated to a temperature of 725 F. and the liquid-vapor stream enters crude distillation column where it is separated into unstabilized gasoline as a top-of-column product, kerosine, light gas oil and heavy gas oil as side streams and reduced crude as the bottoms.

The reduced crude flows to an accumulator from which it is pumped into the direct-fired heater of the visbreaker unit. In this unit, under a pressure of 250 pounds, it is raised in temperature to 920 F., and then enters a reaction chamber where the cracking and visbreaking is completed. Leaving the bottom of this reaction chamber the combined liquid-vapor stream enters the visbreaker fractionator where it is separated into visbreaker gasoline, heavy gas oil, cracking stock, and a heavy residual as bottoms. These bottoms then flow to the vacuum flash tower where, under an absolute pressure of 20 mm. Hg there is produced additional quantity of heavy gas oil to be used as feed stock for the fluid catalytic cracking unit. The bottoms from this vacuum flash tower are blended to fuel oil specifications with, for example, a heavy cycle stock, and pass through a cooler to storage.

This unit is now in operation at the Barrancabermeja, Colombia, refinery of Empresa Colombiana de Petroleos. The crude distillation unit has a capacity of 30,000 barrels per day, and the visbreaker 16,500 barrels per day.



Thermal Cracking—UNIVERSAL OIL PRODUCTS COMPANY

Application: Produces gasoline from every variety of charging stock, from distillates to the heaviest crudes and residual oils.

Thermal cracking produces butylenes and propylene which can be polymerized to produce polymer gasoline of high octane number for use as a blending fluid to improve the quality of other gasolines, or used in alkylation.

Description: The ideal equipment for thermally cracking topped or reduced crudes is centered about the two-coil cracking unit designed for optimum results when producing high-grade cracked fuel oil residuum.

The topped or reduced crude charge is introduced to the side of the fractionating column where it is contacted with the vapors from the flash chamber. The overhead product from the fractionating column is end point gasoline. Furnace or tractor distillates are withdrawn as sidecuts and stripped to specifications. From a lower sidecut tray a higher boiling distillate comprising the lower boiling fractions of both the recycle and charging stocks is withdrawn as charge to the light oil heater. The charge to the heavy oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest boiling fractions of both the recycle and charging stocks.

The transfer lines from the two heaters enter the top of a downflow reaction chamber. This chamber is operated without a liquid level, since all of the products are withdrawn from the bottom through a pressure control valve.

The mixture leaving the reaction chamber enters the flash chamber in which a fuel oil residuum of the desired properties is separated.

Yields: To illustrate the comparative results obtained in various methods of processing, the following yields are presented as representative results when charging a typical 25° API Mid-Continent reduced crude having a viscosity of 20 SFS at 122 F. In considering these results, it must be remembered that not only the gravity but also the viscosity of the charge is important in determining yields.

	Maximum Gasoline	Maximum Furnace Oil
Percent by Volume of Charge:		
Gasoline, 400 E.P., 10 RVP	53.5	38
Furnace Distillate	.....	23
Fuel Oil	37.5	34
Liquid Volume Loss	9	5
Gas, Cu. Ft./Barrel	500	290
F-2 Octane Number, Clear	69–70	68–69
Fuel Oil, Viscosity, SFS at 122 F	200	200
Fuel, Oil Gravity, °API	7	8
Percent Catalytic Polymer Gasoline, 10 RVP	5	3.5
Percent Total Gasoline, including Polymer	58.5	41.5
F-2 Octane Number of Total Gasoline, Clear	71–72	70–71

It should be noted that the cracked gasoline yields are all reported on the basis of 400 F. end point and 10 RVP. On the basis of total butane-butylene retention in the gasoline the yields would be increased approximately 4 percent respectively. The yields of catalytic polymer gasoline shown in the table are on the basis of polymerizing 80 percent of the propylene and butylenes formed in the cracking operation.

Alkylation

THE PRINCIPLE of alkylation as it applies to motor fuel production involves the combination of an isoparaffin, usually iso-butane, with olefins such as propylene, butylene and amylene. The resulting product is a gasoline component with very desirable stability properties and high octanes.

The present capacity of alkylation in the U.S. is 354,000 barrels of product per stream day. This is expected to grow an additional 6,000-7,000 daily barrels before the end of the year so that the total alkylation capacity then will be 360,000 barrels per day. Although the initial capacity was installed to satisfy the war time demands for aviation gasoline, most of the recent installations are being used to make a motor fuel blending stock.

Recent emphasis has been on the modification of existing processes to permit charging larger quantities of propylene. Heretofore, butylene has been the major charge olefin. The switch to propylene and amylenes will give more material for refiners to supplement their olefin supply.

The catalysts used commercially for alkylation are sulfuric acid, hydrofluoric acid, and aluminum chloride promoted with hydrochloric acid. The reaction may be achieved thermally; however, a pressure of 3000-8000 psig is required. On the other hand, if catalyst is used, much lower pressures may be employed. Sulfuric acid alkylation units, for instance, usually are operated at near atmospheric pressure.

Temperature is another important variable in alkylation. If the temperature is allowed to exceed 70 F. in sulfuric acid alkylation, oxidation of the hydrocarbons occurs to such an extent that acid consumption is increased. With hydrofluoric acid, higher temperatures are permitted, although better octane ratings are achieved at lower temperatures.

Alkylation is second to reforming as a means of getting economical octanes. The alkylate will have an F-1 octane rating of around 95 unleaded. Its outstanding characteristic, however, is its relatively high F-2 rating—about 93. This quality is very desirable to compensate partially for the high sensitivity imparted to a gasoline blend by reformed and cracked components.

The new interest in F-2 ratings of motor fuels is generated by some recent trends in automobile engine designs. As the compression of an engine is increased to achieve more power, the engine has a greater tendency to knock at high speeds. The F-2 rating of a fuel is a measure of its ability to satisfy high-speed octane requirements of an engine. Therefore, the refiner desires that some gasoline components have a high F-2.

Other applications of alkylation, besides production of a gasoline blending component, are production of petrochemicals. Ethyl benzene is an example of such a petrochemical. It is produced by combining benzene with ethylene. The product is used in the formation of styrene and synthetic rubber. More of these applications are covered in the Petrochemical Handbook which was published in the November issue of the PETROLEUM REFINER for 1957.

More details on the alkylation process as a source of motor fuel blending components is given in the comprehensive article by R. E. Payne in this issue (p 316).

Isomerization

ISOMERIZATION is the latest processing technique to come into the refining limelight. It involves the rearrangement of straight-chained hydrocarbons to form branched-chained products.

To date the commercial application of isomerization has been for the purpose of converting normal butane to iso-butane. The iso-butane is needed for an alkylation feed because alkylation can often consume more iso-bu-

Charge	F-1 Octane Number		Isomers	F-1 Octane Number	
	Clear	+3cc TEL		Clear	+3cc TEL
n-Pentane	61.7	85.0	iso-Pentane	92.3	103.5
n-Hexane	24.8	65.3	2-Methylpentane	73.4	93.1
			3-Methylpentane	74.5	93.5
			2,2-Dimethylbutane	91.8	104.3
			2,3-Dimethylbutane	102.6	107.8

tane than occurs naturally in a refinery stream. For instance, here is a typical analysis of a C_4 fraction from a reforming operation:

Component	Wt. %
iso-Butylene	20
n-Butylenes	27
iso-Butane	18
n-Butane	35
Total	100

In an alkylation reaction the 47 percent total olefins are capable of uniting with about an equal amount of iso-butane, although only 18 percent is available in the stream. Also, as alkylation units are modified to permit the use of more propylene and amylene, even larger quantities of iso-butane will be needed.

For a motor fuel, often the light materials in the blend have the lowest octanes. Therefore, isomerization now is called upon to do its bit for the octane fight. By converting some of the light materials to their isomers, an increase in octanes is achieved. The octane comparison in the accompanying table shows the improvement that would accrue from isomerizing normal-pentane and normal-hexane.

Some refiners do not believe a separate isomerization process is needed to handle the light fractions of gasoline. They suggest the stocks be charged along with a normal reforming process. Some isomerization will occur and the loss in reformer product octane is compensated for by the increased quantity of material produced.

Three new processes have been added since the last publication of the Handbook. These are the Butamer Process of Universal Oil Products Company (p 258), the Iso-Kel Process of The M. W. Kellogg Company (p 261), and Isomerate Process of the Pure Oil Company (p 263). The first is for the isomerization of butane and the second and third are designed to charge pentanes and heaviers.

The reaction which occurs during isomerization may be represented by the following symbols:

$$\underset{\text{n-Pentane}}{CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3} \rightarrow \underset{\text{iso-Pentane}}{CH_3\text{-}CH_2\text{-}CH(CH_3)\text{-}CH_3}$$

The reaction is carried out in a hydrogen atmosphere in order to hydrogenate any slight amount of cracked materials which may be found as side-reactions to the process. The isomerization reaction neither consumes nor produces hydrogen.

Polymerization

THE PROCESSES, which are used in the industry to make greater quantity and higher quality gasoline, also produce large quantities of gaseous materials. The shift from thermal cracking to a catalytic process is accompanied by the production of gases. Likewise, reforming has this same drawback of breaking down some of the charge material into butanes and lighter. For this reason, polymerization adds to the over-all economy of a refinery.

Latest developments in this field have given the industry a new polymerization process which uses unsupported liquid phosphoric acid rather than the conventional fixed bed of inert material upon which the acid existed as a film. The advantages claimed for this new process are excellent temperature control, high olefin conversion, simplified product recovery, and high operating factors.

Polymerization combines unsaturated materials to yield a product having a higher molecular weight than the feed. Thus, a hydrocarbon like propylene may be polymerized to a material boiling in the gasoline range.

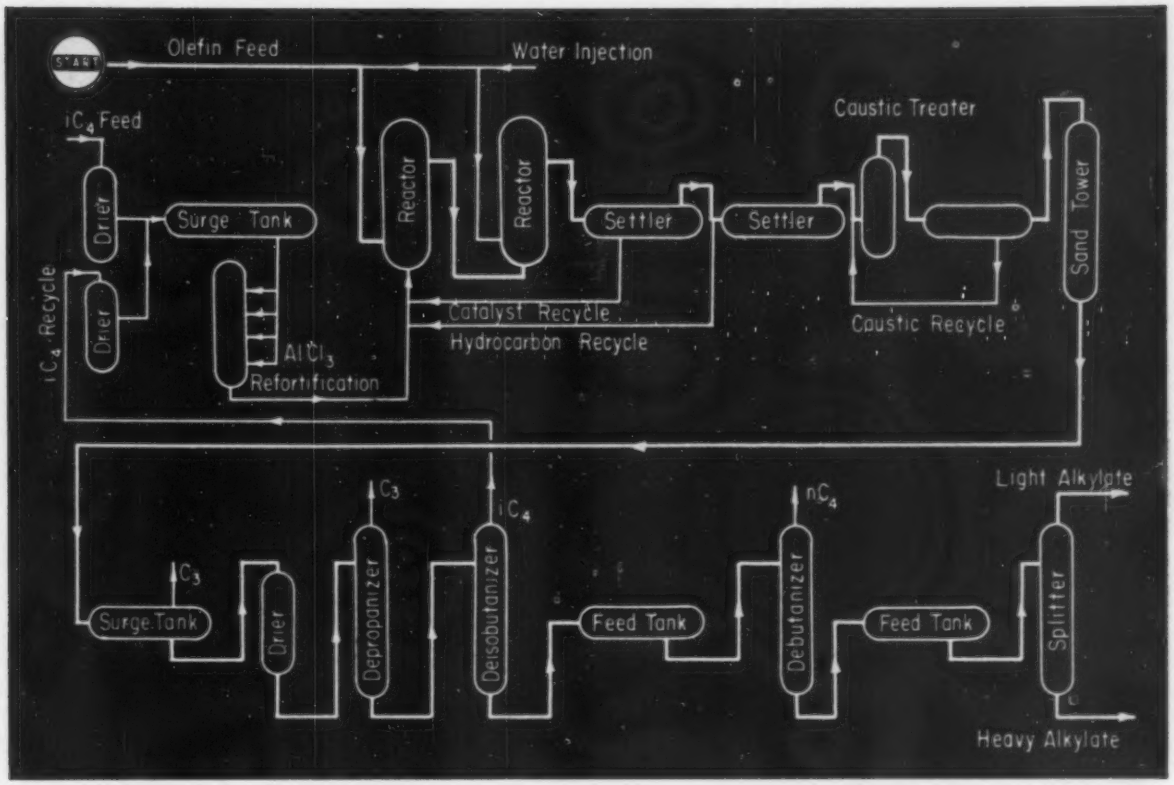
At first, the main objective of polymerization was only to increase the yield of gasoline. Therefore, no attention was given to selective polymerization. Now ethylene figures prominently in the preparation of many petrochemicals and is not normally polymerized for gasoline production. The process deals primarily, then, with the combination of propylenes and butylenes. If the refinery is very large, even the butylenes will not be polymerized, since they will be fed to an alkylation unit.

Polymerization capacity now is about 152,000 barrels of product per stream day. It is the third most desirable processing technique in the refinery—the first two being crude preparation (topping) and some form of cracking. With the present heavy growth in reforming capacity, polymerization is necessary to utilize properly the light olefins poduced as by-products from reforming operations.

As for octanes, polymer gasoline has an F-1 rating of 95-97 unleaded and exhibits about the same lead susceptibility as catalytically cracked gasoline. Its sensitivity (12-14 octane numbers) is a little greater than cracked stocks.

Polymerization is not strictly an octane improving process, since it is used in the refinery to make gasoline blending components from materials which are not in the gasoline boiling range. The process' growth, then, does not parallel the present rapid growth in reforming, nor the trend to greater growth shown by alkylation. It, nevertheless, is important in the over-all refinery economy and is beginning to take a greater role in petrochemicals.

Even now, the high molecular weight olefins from polymerization furnish raw materials for detergent production. When olefins are polymerized for this purpose, the lower molecular weight materials are recycled to achieve greater yields. Polymerization also furnishes raw material for some Oxo processes in which the olefins are converted into industrial alcohols and aldehydes.



Aluminum Chloride Alkylation—PHILLIPS PETROLEUM COMPANY

Application: For conversion of normally gaseous hydrocarbons to high octane motor fuel.

Charge: Ethylene, propylene and isobutane.

Product: A high quality material boiling in gasoline range.

Description: Dry fresh feed is charged to a stirred reactor. Intermittent addition of catalyst to the system is accomplished by passing the isobutane charge through a catalyst make up drum. The reactor effluent passes through a primary settler for phase separation of hydrocarbon and catalyst. The catalyst is recirculated to the primary reactor.

A major portion of the effluent from the primary settler is recycled through a cooler to the first reactor for control of effluent temperature from the second reactor in the range of 120 F. The reactors normally operate with a 3 degree rise in temperature.

The remaining portion of hydrocarbon from the primary settler passes to a second settler for final removal of any entrained catalyst then to a caustic washer before entering the fractionation section.

Catalyst employed is aluminum chloride existing as a hydrocarbon complex. HCl is an active promoter of catalyst activity and is produced by injecting a controlled amount of water into reactors.

Propane and lighter hydrocarbons are yielded as an overhead gas from a depropanizer, isobutane is yielded overhead from a deisobutanizer and recycled to the reactors. The bottom product from the deisobutanizer is fractionated for end point control in an alkylate splitter.

Operating Conditions:

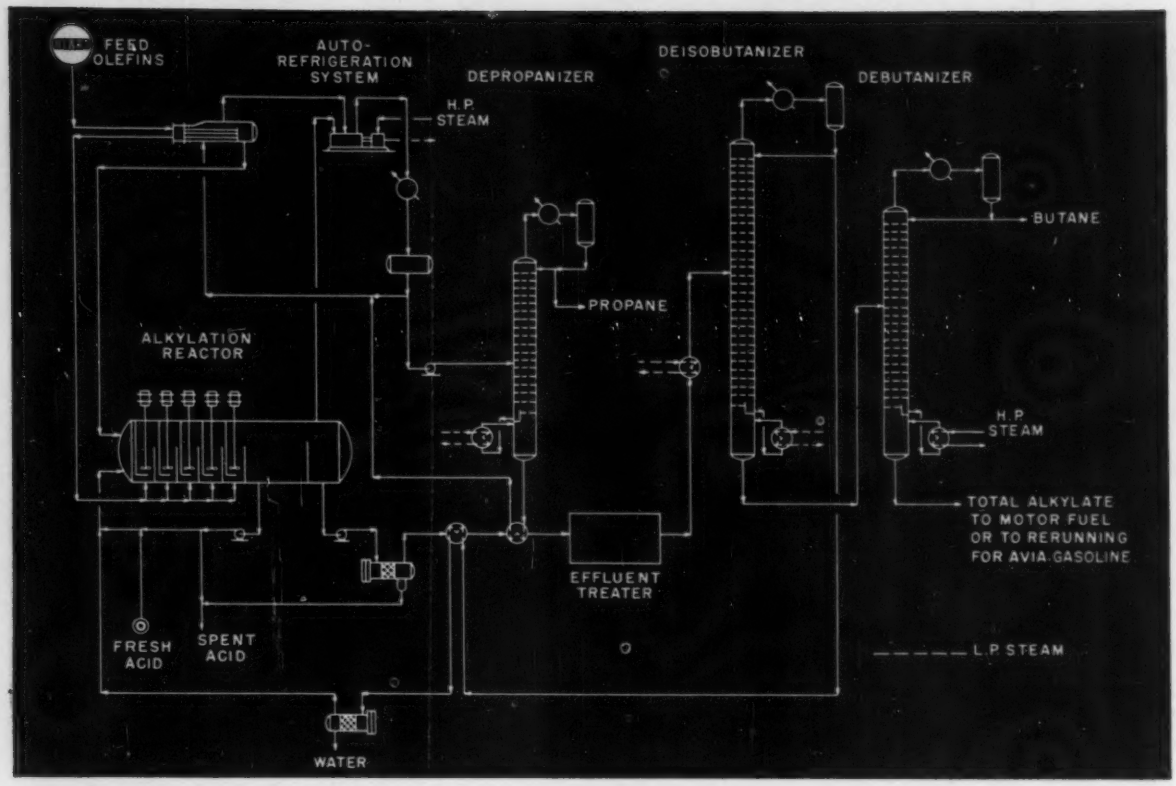
Olefin Feed Components, Mol %	
Methane	12.5
Ethylene	45.2
Ethane	15.8
Propylene	23.2
Propane	2.7
Butane	0.7
Total	100.0
Motor Alkylate Properties	
Yield, % of total alkylate	95.0
R.v.p. (undebutanized)	9.0
*A.P.I.	74.0
A.S.T.M. distillation, °F.	
I.b.p.	110
10 percent	129
20 percent	140
50 percent	159
90 percent	300
95 percent	363
E.p.	425
F-1 octane number:	
Clear	95.1
1 cc TEL/gal.	*102.7
3 cc TEL/gal.	†109.5

* Equivalent of A.S.T.M. research method rating of 0.15 ml. TEL in isooctane.

† Equivalent of A.S.T.M. research method rating of 1.10 ml. TEL in isooctane.

Economics: Investment cost for a battery limits plant based on an operation to produce motor fuel alkylate will range from approximately $1300 to $550 per barrel for alkylate productions of 1,000 bpd to 10,000 bpd, respectively. Utilities and chemicals requirements are given in the accompanying table.

Utilities	Unit/Bbl. Total Alkylate
Steam (million Btu absorbed)	0.44
Cooling-water circulation, 1000 gal., 20° rise	2.6
Makeup water, 1000 gal.	0.08
Power, kw-hr.	3.3
Chemicals	
Caustic, lb.	0.015
Aluminum chloride, lb.	2.80



Cascade Sulfuric Acid Alkylation—THE M. W. KELLOGG COMPANY

Application: Converts refinery olefins to super octane quality gasoline by selective reaction with isobutane in the presence of sulfuric acid catalyst.

Charge. Propylene, butylenes and/or amylenes from any source and isobutane.

Product: Superior octane alkylate for aviation or premium and super-premium motor gasolines, capable of imparting exceptional road performance and particular freedom from combustion chamber deposits.

Description: The cascade process has been developed to minimize side reactions which cause both degradation of acid and loss of octane quality. The reaction conditions which achieve this end are:

1. High isobutane concentration;
2. Low olefin concentration;
3. Low temperature.

In the Cascade System dilute olefin concentration is achieved by splitting the olefin feed into a number of parallel streams each of which is fed to a separate reaction compartment containing its own mixer. Low temperature is maintained by allowing vaporization in each zone to remove heat of reaction. This auto-refrigeration provides a more efficient and economic refrigeration cycle than would be possible if heat exchange or pressure reduction systems were used. The condensed refrigerant is depropanized and mixed with recycle isobutane and acid catalyst. This mixture flows in series through the reaction compartments, achieving the effect of many reactors each receiving the total recycle and all of the refrigerant isobutane which will vaporize in later zones. The effect of this arrangement on the isobutane content and isobutane/olefin ratio are shown in the accompanying table. These high ratios could not have been achieved if the isobutane and olefin streams were mixed prior to entering the reactor system.

Reactor effluent, which contains the reaction products, recycle isobutane, and inert components of the feed, is separated from the acid catalyst in the settling zone of the reactor, treated to remove entrained acidic materials and fractionated to separate isobutane recycle from the net plant effluent. The net effluent is debutanized to yield butane and total alkylate which can be blended directly with motor fuel or rerun for use in aviation gasoline.

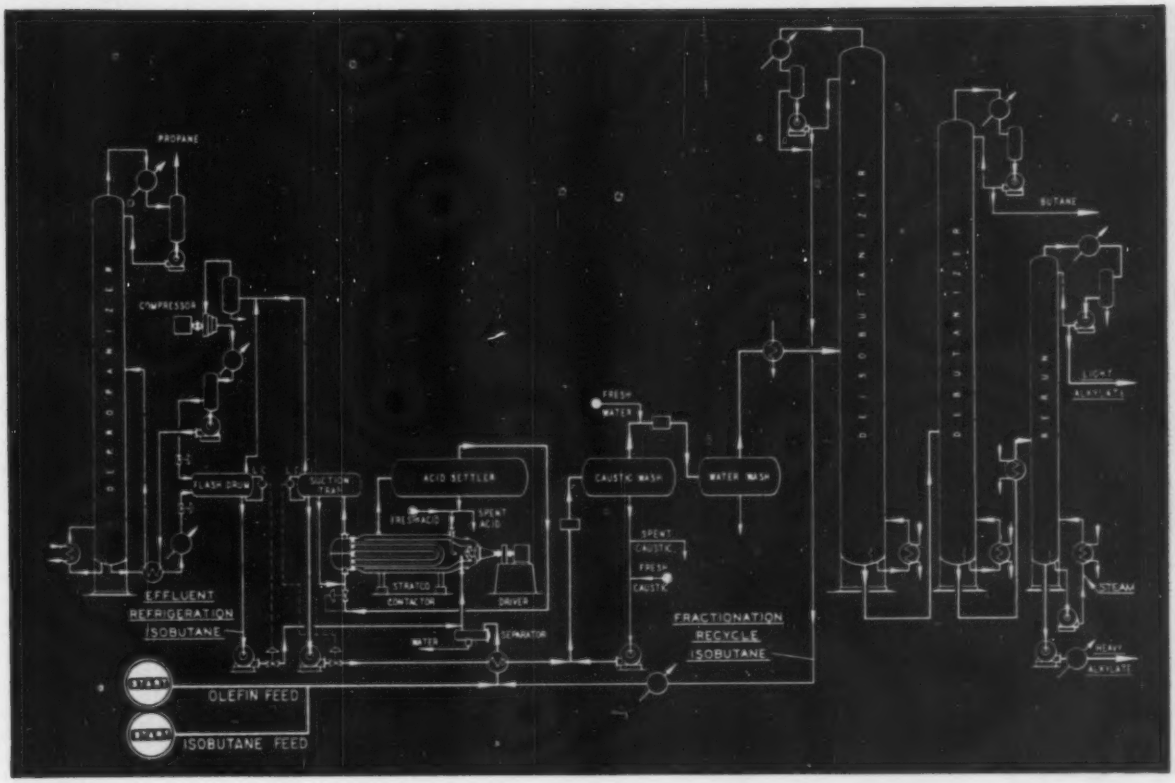
Operating Conditions: Typical operating conditions for a five-zone Kellogg Cascade reactor are given in the following table:

Zone No.	% iC_4	iC_4/olefin ratio (external)
1	83.0	30.5
2	76.0	26.2
3	68.5	22.1
4	59.8	18.1
5	50.5	14.3
average	67.6	22.2
Temperature	35 - 45°F	
Fresh Acid strength	98 - 99%	

Typical Yields:

Olefin Feed Type	Propylene	40%C_3—60%C_4—	Butylenes	Pentenes
Yield-Bbl. Alkylate per bbl. olefin	1.78	1.74	1.72	1.60
Isobutane Consumption, Bbl. iC_4 per Bbl. Olefin	1.275	1.174	1.106	0.965
Acid Consumption (Avg.): Lbs. 98% H_2SO_4 per Gal. Total Alkylate	2.5-0.84	1.5-0.6	0.84-0.33	1.0-0.4
338°F End Point Alkylate Quality:				
F-1 O.N., Clear	89-92	92-95	94-97	90-93
+3.0cc TEL/Gal.	101.5-103.0	103.5-105.0	104.2-106.3	103-103.6
F-2 O.N., Clear	87-90	90-93	92-94	90-92
F-3 (1-C) P.N., +4.6cc TEL 1 Gal.	117-122	124-127	127-132	116-123
F-4 (3-C) P.N., +4.6cc TEL 1 Gal.	129-142	141.6-154	150-165	136-148

Commercial Installations: A total of 28 autorefrigerated units have been built, 19 of which incorporate the cascade principle. Four additional units are in various stages of design and construction.



Effluent Refrigeration Alkylation—STRATFORD ENGINEERING CORPORATION

Application: Combines propylene, butylenes, and amylenes with isobutane in the presence of strong sulfuric acid to produce high octane branched chain hydrocarbons (alkylate) for use in aviation gasoline and motor fuel. Effluent Refrigeration is essentially a means of obtaining economically a very high concentration of isobutane in the reaction mixture with little conventional isobutane fractionation. It may be applied to new plants, or to existing alkylation plants, for the production of higher quality alkylate or for increased production.

Product: Most of the recently installed plants and the majority of those being currently installed are designed to process a mixture of propylene and butylene. The total debutanized alkylate from these plants has F-1 octane numbers of 92-96 clear and 102-107 with 3 cc TEL. When processing straight butylenes, commercial installations have produced debutanized total alkylates having F-1 octane numbers as high as 97.5 clear and 111.0 with 3 cc TEL. Endpoints of the total alkylates from both mixed feeds and straight butylene feeds have averaged between 360F. and 400F. in most cases. The alkylates may be rerun to produce 96-98 percent of 338 F. endpoint aviation alkylates having 3-C performance numbers of 150-165 (4.6 cc TEL).

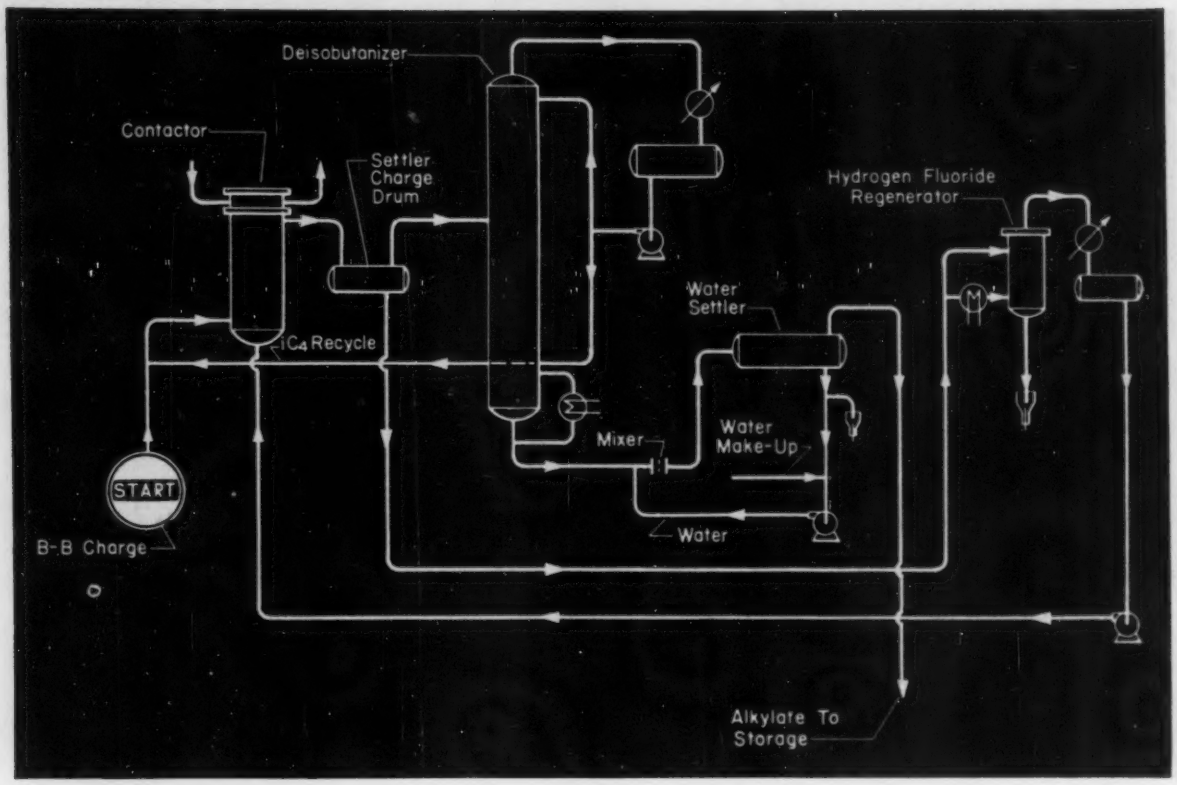
Description: The feed streams along with a recyle stream of H_2SO_4 are charged to the contactor. The liquid contents of the contactor are circulated at high velocities and an extremely large amount of interfacial area is exposed between the reacting hydrocarbons and the acid catalyst. The entire volume of the liquid in the contactor is maintained at a uniform temperature. The maximum deviation between any two points within the reaction mass is 1 F.

The overhead from the deisobutanizer and the effluent refrigerant recycle together constitute the total isobutane recycle to the reaction zone. Normally, approximately 60 percent of the external isobutane recycle comes from the effluent refrigeration recycle and only 40 percent from the deisobutanizer. No portion of the isobutane recycle is permitted to vaporize from the reaction zone. The total quantity of isobutane recycle is present in liquid phase throughout the reactor, thereby serving to promote the alkylate reaction to the same extent as equivalent isobutane from a deisobutanizer. Isobutane concentration in the hydrocarbon phase leaving the reactor normally ranges between 60 and 80 volume percent.

Alkylates produced by effluent refrigeration normally have an endpoint under 400 F. so that if the alkylate is to be used for motor fuel it need not be rerun.

Commercial Installations: Thirteen commercial plants employing effluent refrigeration are now in operation, five are under construction and a considerable number are in the design stage.

Reference: PETROLEUM REFINER, vol 34, no 9, p 148 (Sept. 1955).



HF Alkylation—UNIVERSAL OIL PRODUCTS COMPANY

Application: For combining an isoparaffin with an olefin, or mixtures of olefins, to form a highly-branched paraffinic product which is used as a blending component in the manufacture of aviation gasoline and automotive gasoline.

Catalyst: Anhydrous hydrogen fluoride.

Charge: Isobutane may be alkylated with propylene, butylenes, amylenes, or even higher boiling olefins, such as tetramer and pentamer, and olefinic mixtures from thermal or catalytic cracking. Butylenes, or butylenes-plus-propylene are the most common olefin charge stocks.

Description: The HF Alkylation process shown schematically in the flow diagram is arranged for the production of motor fuel alkylate. It consists essentially of a water-cooled reactor operating between 60 and 100 F., and under pressure sufficient to assure liquid phase operation; a combined settler and charge drum; recycle column, or deisobutanizer, and catalyst regenerator.

Additional equipment required for an aviation alkylate includes a rerun column, bauxite towers, debutanizer and a depropanizer.

This process is especially applicable where isobutane in excess of that required to provide the desired gasoline vapor pressure is available. Acid consumption is no higher for propylene and amylenes than for the butylenes and, also make-up acid costs are low. Moreover, there is no acid disposal problem. This process is excellent for making the 100-plus octane components for aviation and motor fuel blending. Safety and corrosion records on the new units compare favorably with or exceed experiences with other refinery process units.

The incoming charge, usually a mixture of isoparaffin with a controlled amount of olefins, is mixed with additional isoparaffin as recycle and then enters the contactor where it is brought into intimate contact with the HF catalyst. The effluent is settled. The bottom product, hydrogen fluoride, is sent to regeneration and then recycled to the contactor.

The settler overhead product is deisobutanized, the bottom product being alkylate which is washed with dilute caustic and sent to storage. The overhead product of the column is the isoparaffin recycle previously mentioned.

Product and Yields: Requirements of isobutane, alkylate product qualities and yields when charging butylenes and propylene are shown in Table 1. Analytical data and antiknock ratings for a rerun butylene alkylate are shown in Table 2.

Commercial Installations: HF Alkylation plants were operated during World War II for the production of 100-plus octane avgas. Some of these units have since been operated to manufacture motor gasoline. Additional HF units have been built in recent years; more are under construction and planned. Installation costs for motor alkylate plants run from $700 to $1,000 per barrel in sizes down to 500 bpsd of 3.5 psi RVP product, depending upon capacity and feed preparation required.

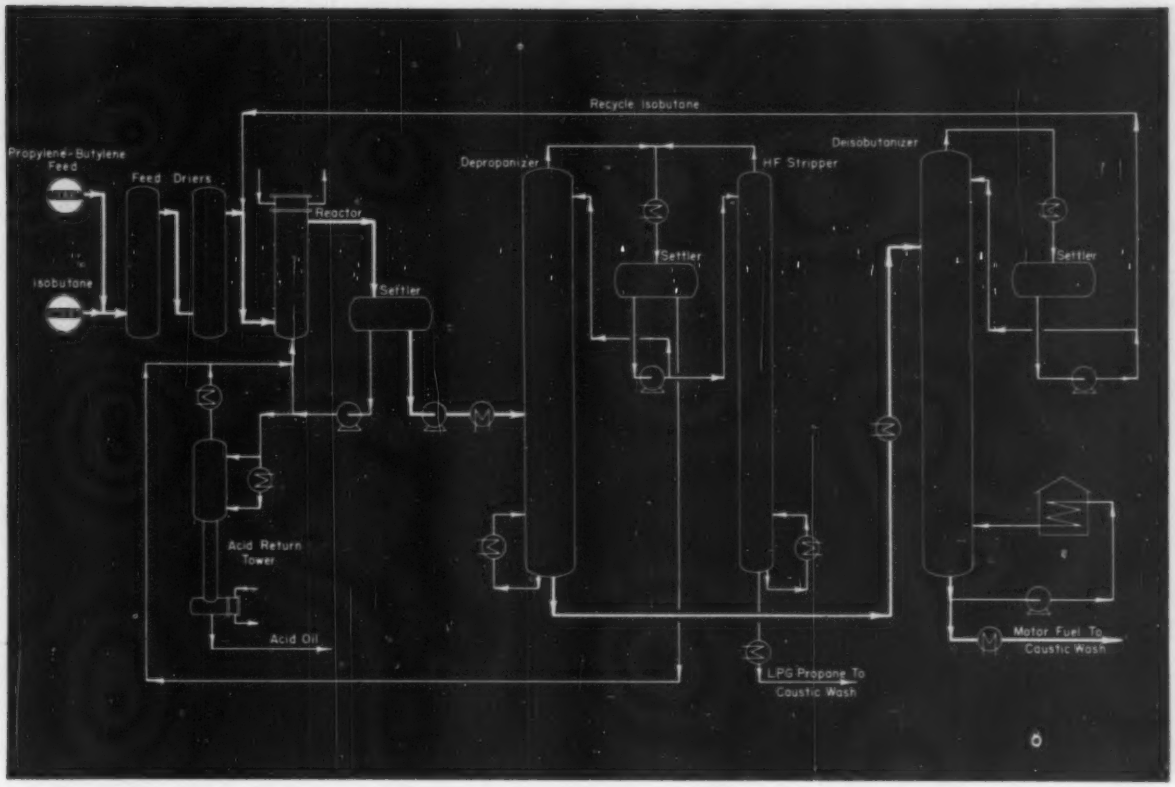
Reference: Jones, E. K., "Commercial Alkylation of Paraffins and Aromatics," *Advances in Catalysis*, X, pp. 165-195, Academic Press, Inc., New York (1958)

Table 1

	Vol./Vol. Olefin		Research Octane No.		Motor Octane No.	
	Isobutane	Alkylate	Clear	+ 3 cc TEL/Gal.	Clear	+ 3 cc TEL/Gal.
Butylenes	1.16	1.75	96+	iso + 0.9 cc TEL	94	iso + 0.9 cc TEL
Propylene	1.33	1.77	93	iso + 0.3 cc TEL	91	iso + 0.35 cc TEL

Table 2

Gravity, °API	71.6
Reid Vapor Pressure, psi	4.3
Total Alkylate, Volume Percent	97.5
Engler Distillation, °F.	
I.B.P.	102
10 Percent	176
50 Percent	**217**
90 Percent	231
E.P.	336
Antiknock Ratings with 4.6 cc TEL/Gal.	
F-3, Performance Number	129.3
F-4, Iso + cc TEL/Gal.	3.9
F-4, Performance Number	152.0



HF Alkylation, Perco—PHILLIPS PETROLEUM COMPANY

Application: For conversion of normally gaseous hydrocarbons to high octane gasoline.

Charge: Olefins and isobutane.

Product: Motor fuel or aviation gasoline.

Description: The essential features of the Perco HF Alkylation Process for the production of motor fuel from a propylene-butylene feed stock are shown in the flow diagram. With minor variations this design may be used with any olefin feedstock to produce either motor fuel or aviation gasoline.

Liquid feed containing olefins and isobutane is passed through bauxite driers and fed into the lower section of the reactor, while the liquid hydrofluoric acid enters the reactor through a recycle line connected to the bottom of the reactor. The alkylation reaction is completed by intimate contacting, after which the hydrocarbon and acid flow to the settler where a two-phase separation occurs. The acid phase is recycled to the reactor. The hydrocarbon phase is fed to the fractionating section where the propane and recycle isobutane are separated from motor fuel alkylate.

The reactor effluent is water-cooled to a temperature of 85 to 95 F., depending upon seasonal changes in cooling water temperature. Variation within this 10 F. temperature range does not have an appreciable effect on either product quality or operating cost. The acid-hydrocarbon ratio of the reactor feed is not critical and may range from 0.2:1 to 1:1. For the purpose of product quality control, an excess of isobutane is recycled to the reactor with the olefin. External isobutane-to-olefin ratio from 2:1 to 20:1 have been used but for motor fuel production the optimum will be approximately 7:1.

As an auxiliary to the operation, an acid rerun is provided for continuously purifying the hydrofluoric acid catalyst.

The present acid-hydrocarbon reactor is not equipped for mechanical agitation and is essentially a shell and tube heat exchanger. In addition to simplifying the unit operation, these revisions considerably reduce both the investment requirements and the operating expense; only two men are required to operate a unit of this design.

Yields: A typical operation for a propylene-butylene cut from a catalytic cracking operation based on 100 bpd total feed is shown.

Charge to Unit, Bbl.		Yields From Unit, Bbl.	
Propane	7.5	Propane	9.8
Propylene	11.5	Isobutane	2.3
Butylene	20.4	N-Butane	14.2
Isobutane	46.4	Alkylate	56.2
N-Butane	14.2		
TOTAL UNIT FEED	100.0	TOTAL YIELD	82.5

Debutanized Motor Fuel Alkylate:

Gravity, °API	68.8
ASTM Distillation, °F	
IBP	160
50% evap.	224
E. P.	392
Color, Saybolt	30
Doctor Test	Negative
Corrosion, 122°F	Negative
ASTM Gum	0.4 Mg/100 Ml.
F-1 Octane Number	
Clear	92.5
+1 cc TEL/gal.	99.5
+3 cc TEL/gal.	103

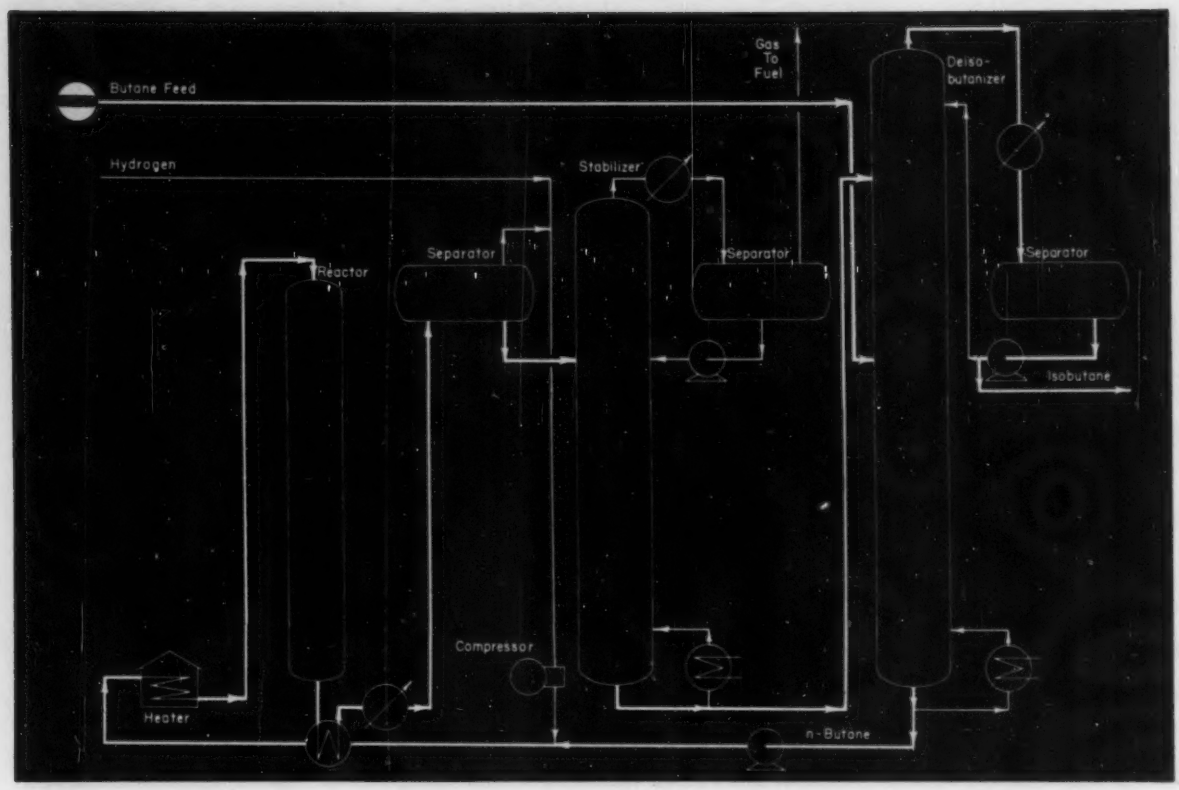
Operating Service Factor: 98% normal

Economics: Investment will range from $750 to $1,000 per barrel of alkylate produced, depending upon the type of feed stocks and desired motor fuel specifications. Operating costs are summarized in the accompanying table.

Cost Items:

Labor and Materials	Unit/Bbl.Alky.	$/Bbl.Alky.
Operating Labor (2 Men/Shift)	—	0.0800
Supervision & Laboratory	—	0.0800
Repair Labor & Materials	—	0.1600
Utilities		
Fuel @ $0.10/MM BTU	0.53 MM BTU Absorb.	0.0757 (70% eff.)
*Water Circul'n @ $0.015/M Gal.	3.56 M Gal.—20° Rise	0.0534
Make up Water @ $0.09/M Gal.	0.07 M Gal.	0.0063
Electric. Power @ $0.0057/KWH	3.50 KWH	0.0200
*Includes Power and Treating		
Chemicals		
Caustic @ $0.035/Lb.	0.1430	0.0050
HF Acid @ $0.21/Lb.	0.2700	0.0567
Miscellaneous		0.0100
TOTAL		0.5471

Reference: PETROLEUM REFINER, vol 34, no 9, p 126 (Sept, 1955).



Butamer—UNIVERSAL OIL PRODUCTS COMPANY

Application: For economically converting normal butane to isobutane under mild processing conditions by means of a catalyst in the presence of hydrogen.

Product: The once-through product contains up to equilibrium concentrations of isobutane; in recycle operation, normal butane is converted to high purity isobutane at 100 percent volumetric yields.

Catalyst: A stable, rugged, long-lived, non-corrosive solid containing platinum, capable of functioning efficiently at relatively low operating temperatures for long periods of time. The high activity permits operating at economical liquid hourly space velocities with low catalyst inventory.

Description: A typical Butamer processing unit is illustrated in the simplified flow diagram above. The fresh butane feed, which may also contain isobutane, is charged to a deisobutanizer; the bottom product is essentially pure normal butane. Next, the butane is mixed with hydrogen (conveniently obtained from a Platforming unit), heated and charged at moderate pressure to the reactor containing the special catalyst. The reactor effluent is cooled, unconsumed hydrogen is separated from the liquid in a separator for recycle via a compressor, and the liquid then is stabilized in a conventional column. The stabilizer bottom product is deisobutanized, and high purity isobutane is taken overhead as product, together with any isobutane introduced in the fresh feed. The deisobutanizer bottom product, as previously mentioned, is the recycled normal butane and that normal butane present in the fresh feed, which is sent as combined feed to the reactor section. The tendency to form carbon on the catalyst is considerably less in the Butamer process than in catalytic reforming of straight-run gasolines and naphthas. This results from the low molecular weight of the charge and the high activity and selectivity of the catalyst, which catalyst permits the use of mild processing conditions. A small chemical hydrogen consumption results from the formation of minor amounts of methane, ethane and propane. A small quantity of hydrogen also appears in the stabilizer overhead gas; it represents the so-called "solution loss." The hydrogen-to-charge ratio is low.

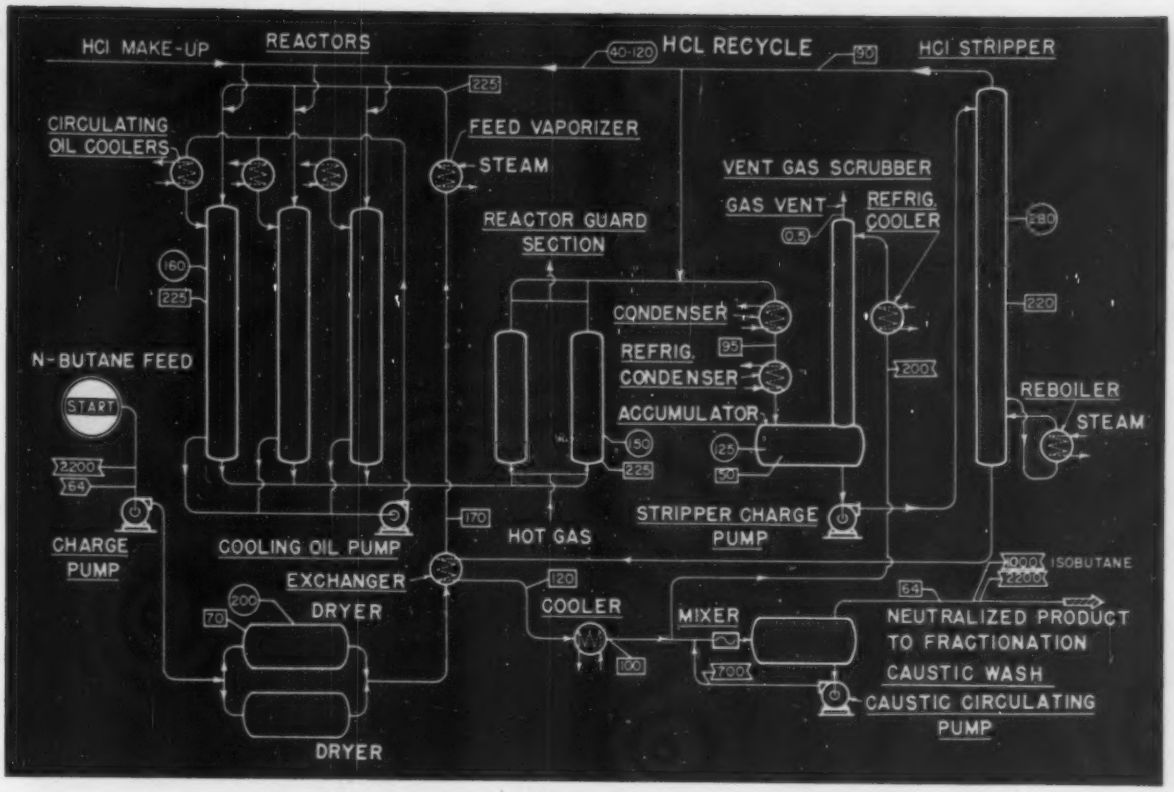
Yields: When yields are computed on a volumetric basis, starting with 100 volumes of normal butane, the ultimate yield is greater than 100 vol. %.

Economics: Process investment and operating costs are given in the table for a plant producing 2,000 bpsd of isobutane product. Roughly a third of the investment is represented by the deisobutanizer but, normally, a Butamer unit would be integrated with an alkylation unit—in new construction, particularly—and thus it may be designed as a single column to meet the combined requirement of both units. Therefore, the over-all investment for the two units is substantially lower than if each were built as totally independent entities.

Reference: *The Oil and Gas Journal,* vol 56, no 13, p 73 (March 31, 1958).

Butamer Process Economics

Process Investment, 2,000 bpsd isobutane product		$1,300,000
Operating Costs, ¢/gal. isobutane:		
Labor	0.25	
Utilities	0.75	
Catalyst	0.25	
Maintenance, taxes, etc.	0.20	
	1.45	



Butane Vapor-Phase Isomerization—SHELL DEVELOPMENT COMPANY

Application: For the isomerization of butane to isobutane.

Description: The process consists of passing normal butane vapor, at a moderate temperature, through a reactor or bank of reactors packed with a granular catalyst containing aluminum chloride. Dry hydrogen chloride gas is incorporated with the butane vapors to act as a catalyst promoter. The reactors may each consist of a single catalyst bed, or may be of a heat-exchanger type with the catalyst placed in tubes surrounded by circulating cooling liquid.

In typical plants the hydrocarbon charge is first pumped through a regenerative drying unit. It is then completely vaporized before it enters the reactors, together with a measured amount of hydrogen chloride recycle gas. The reactor effluent flows to a receiver through a cooler and a refrigerated condenser which condenses all the butanes, the hydrogen chloride going into solution. A small amount of uncondensable gas is vented from the receiver after being scrubbed with product recycle to recover hydrogen chloride. The condensate is charged to an HCl stripping column which effects substantially complete removal of recycle hydrogen chloride gas. Butanes, essentially free of hydrogen chloride, flow from the base of the column, while vapors, consisting largely of hydrogen chloride, are recycled to the reactors. Traces of hydrogen chloride in the isomerized product are removed by caustic scrubbing. The catalyst is resistant to poison, but it is necessary to reduce the proportion of olefins and pentanes in the charge stock to a low figure, since both of these produce objectionable by-products and tend to shorten the life of the catalyst.

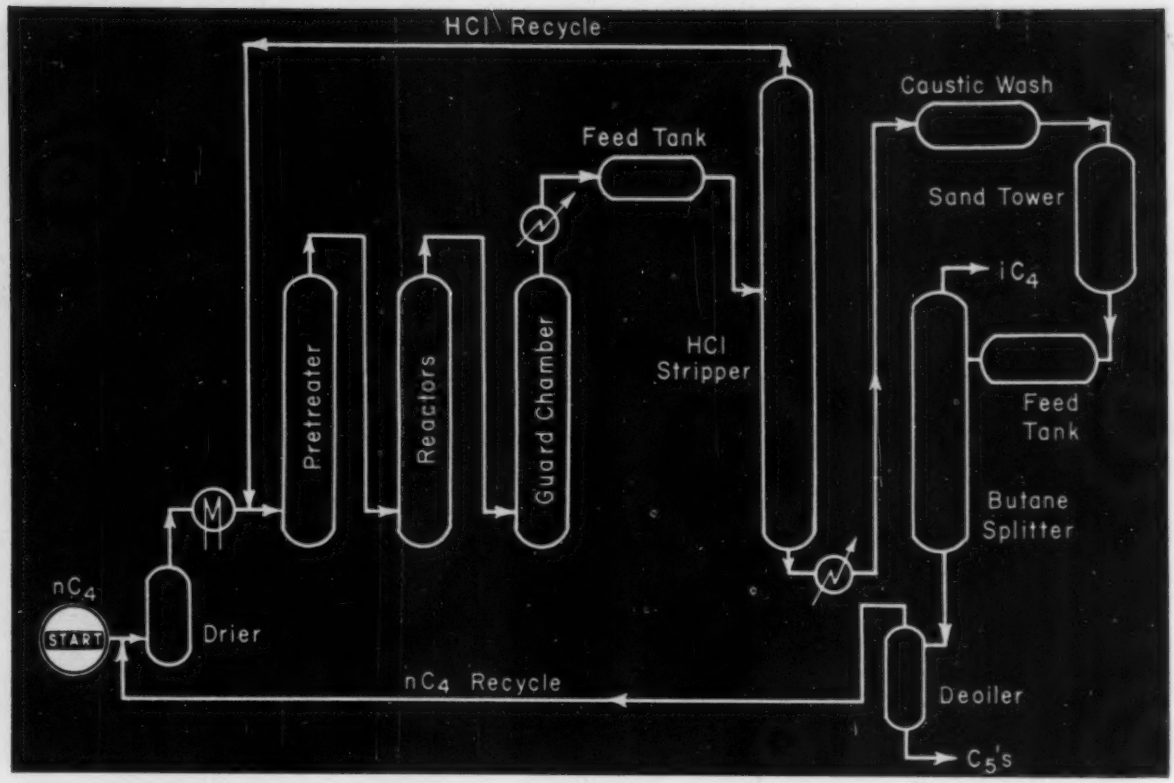
Operating Conditions: The table illustrates typical operating data.

	Plant 1	Plant 2
Normal butane charge to reactor, Bbl./Day	3510	1720
Isobutane in product, volume percent	47.6	42.2
Reactor inlet temperature, °F.	253	213
Reactor pressure, lbs./sq. in. gauge	262	163
Hydrogen chloride in reactor feed, mole percent	16.8	11
Catalyst consumption, lb./day	3180	1120
Alumina ($AlCl_3$ absorber) consumption, lb./day	779	684
Hydrogen chloride consumption, lb./day	†	91
Isobutane produced, gal./lb. catalyst	24.0	27.1
On stream time, percent	96.7	91.7
Space velocity in catalyst bed, liq. vol./vol./hr.*	1.01	0.84
Space velocity in $AlCl_3$ absorber, liq. vol./vol./hr.*	1.50	1.83

* Based on plant feed.
† Quantitative figures unavailable.

Commercial Installations: Nine units
Shell Oil Company, Inc., Houston
The Texas Company, Port Arthur, Texas
The Texas Company, Lockport, Ill.
Richfield Oil Company, Watson, Calif.
Tide Water Associated Oil Company, Avon, Calif.
Union Oil Company, Wilmington, Calif.
Sinclair Refining Company, Sinclair, Wyo.
Trinidad Leaseholds, Ltd., Trinidad, B.W.I.
Curacaosche Petroleum Ind. Mij., Curacao, N.W.I.

Reference: Trans. A I Ch E, vol 42, p 595 (1946).



Catalytic Isomerization—PHILLIPS PETROLEUM COMPANY

Application: Isomerization of normal butane to produce a high-yield, high-purity isobutane is performed by a vapor phase catalytic treatment of dry normal butane wherein the catalyst utilized is aluminum chloride promoted with HCl.

Description: The dry normal butane feedstock is first vaporized and superheated and then, after being mixed with recycle HCl vapors, is fed to a pretreater. The pretreated feed next passes to the reactor.

The pretreater and reactor are bed type chambers containing aluminum chloride sublimed on bauxite. The reactor effluent, consisting of isobutane, normal butane and trace side reaction products, passes through a bauxite-filled guard chamber and then is condensed in a series of effluent exchangers. Removal of trace noncondensables from the liquid effluent stream is performed in a vent gas absorber and HCl vapor is removed by stripping. HCl vapor overhead from the stripper is recycled to the feed pretreater.

The bottoms product from the stripper passes through a caustic washer and sand filter before being charged to the fractionation section which consists of a deisobutanizer and a deoiler tower. High purity isobutane is yielded as an overhead product from the deisobutanizer. The normal butane overhead product from the deoiler is recycled to the driers. A small quantity of pentane and heavier production is yielded as a bottom product of the deoiler tower.

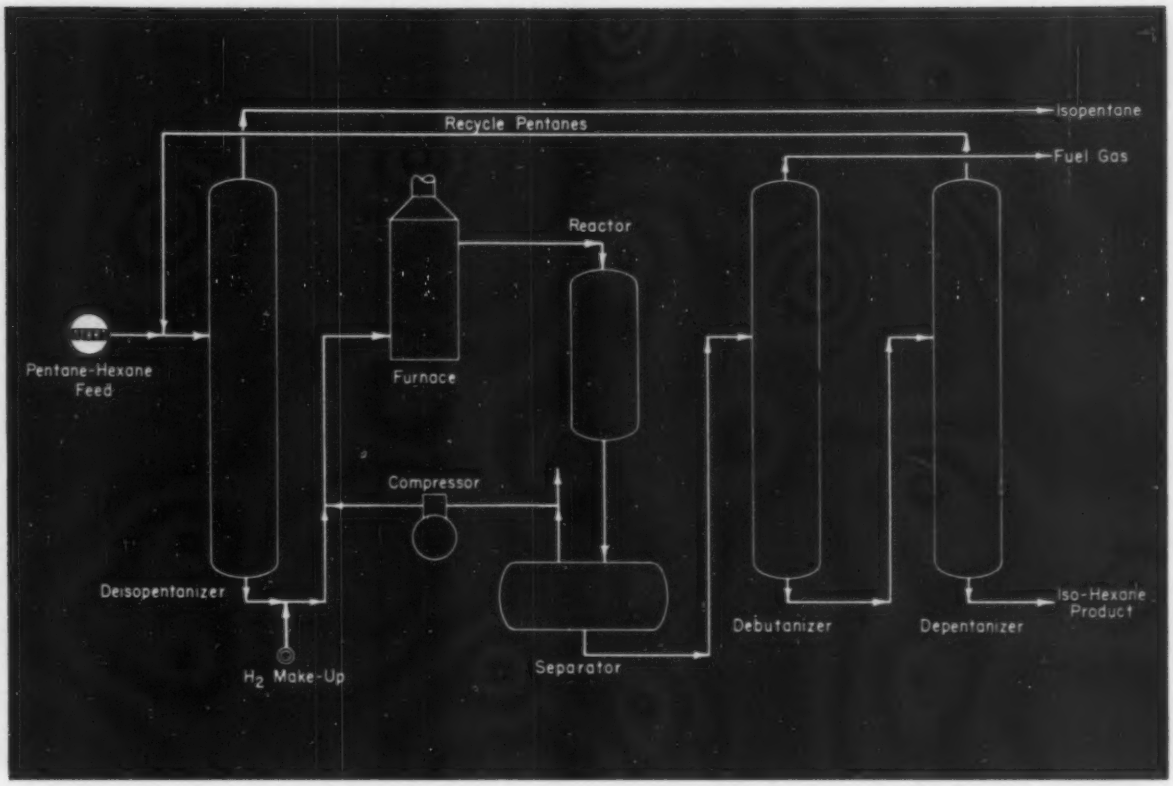
Addition of catalyst to the system is accomplished by subliming aluminum chloride with the hot feedstock and depositing it on the bauxite in the pretreater and the reactor. Make up HCl is injected into the system down stream of the effluent exchangers.

Yields: Typical process information is presented in the following tabulations:

Basis: 100 barrels of charge—50 percent conversion per pass.

	Charge (Bbl.)	Isobutane Yield (Bbl.)	Deoiler Bottoms (Bbl.)	Vent Gas (s.c.f.)
Ethane and Lighter	....	....	....	Trace
Propane	....	5	....	....
Isobutane	2	85	....	....
Normal butane	96	2	....	....
Pentane plus	2	....	8	....
	100	92	8	....

Utilities (Unit/Bbl. Isobutane Produced):	
Water circulation, 1,000 gallons	1.5
Water Make-up, 1,000 gallons	0.045
Power, kw.-hr.	1.54
Steam, 1,000 lb.	0.680
Chemicals (Lb./1,000 Bbl. iC_4 Produced):	
Aluminum chloride	85
HCl	70
Bauxite	440
Driocel for driers	7
Caustic	89



Iso-Kel—THE M. W. KELLOGG COMPANY

Application: For isomerizing low octane natural or refinery pentanes and hexanes to superior, high-octane isoparaffinic blending stock, using an exclusive noble metal catalyst in the presence of hydrogen.

Charge: Pentanes and hexanes from crude oil, natural gasolines, condensates, or produced by cracking, reforming or hydrogenation. Mixed pentane-hexane feeds are efficiently isomerized in a single reactor.

Product: Isopentane of 104 leaded octane number and isohexanes of leaded octane up to 93.5 are produced separately for blending flexibility. These pure, stable fuels provide necessary front-end volatility to premium and super premium gasolines while reducing sensitivity and contributing exceptional engine performance characteristics.

Description: Depending upon feed stock quality and degree of upgrading desired, the process scheme will be varied to allow for prefractionation of isomers in the feed and recycle of unconverted material. In simplest form pentanes are processed on a recycle basis and hexanes once-through. However, by the addition of deisohexanizer and dehexanizer the hexanes can be recycled to produce a higher quality isohexane product. The simplified flow diagram shown is suitable for either a pentane operation or a mixed pentane-hexane feed. The unit is divided into two sections; a feed preparation section, and a reaction section.

The feed preparation section consists of three fractionating towers. In the deisopentanizer the recycle pentane stream and the pentane-hexane feed are fractionated to separate an isopentane product of 95 or higher purity. The bottoms from this column are in charge to the reaction section. Following the reaction system, the liquid is fed to a debutanizer to remove a small quantity of absorbed gas. The bottom product from the debutanizer is charged to the depentanizer in which the unconverted pentanes are removed overhead and recycled back to the deisopentanizer. Depentanizer bottoms are the isohexane product.

The heart of the process is a precious metal catalyst (not platinum) of extreme selectivity developed in the Kellogg laboratory. Extraneous hydrogen is used to control the pressure in the reaction section and to provide a small hydrogen consumption necessary in the reaction. While with normal operating conditions catalyst regeneration is not required the Iso-kel catalyst is capable of regeneration in place should operating upset cause coke to be deposited upon it.

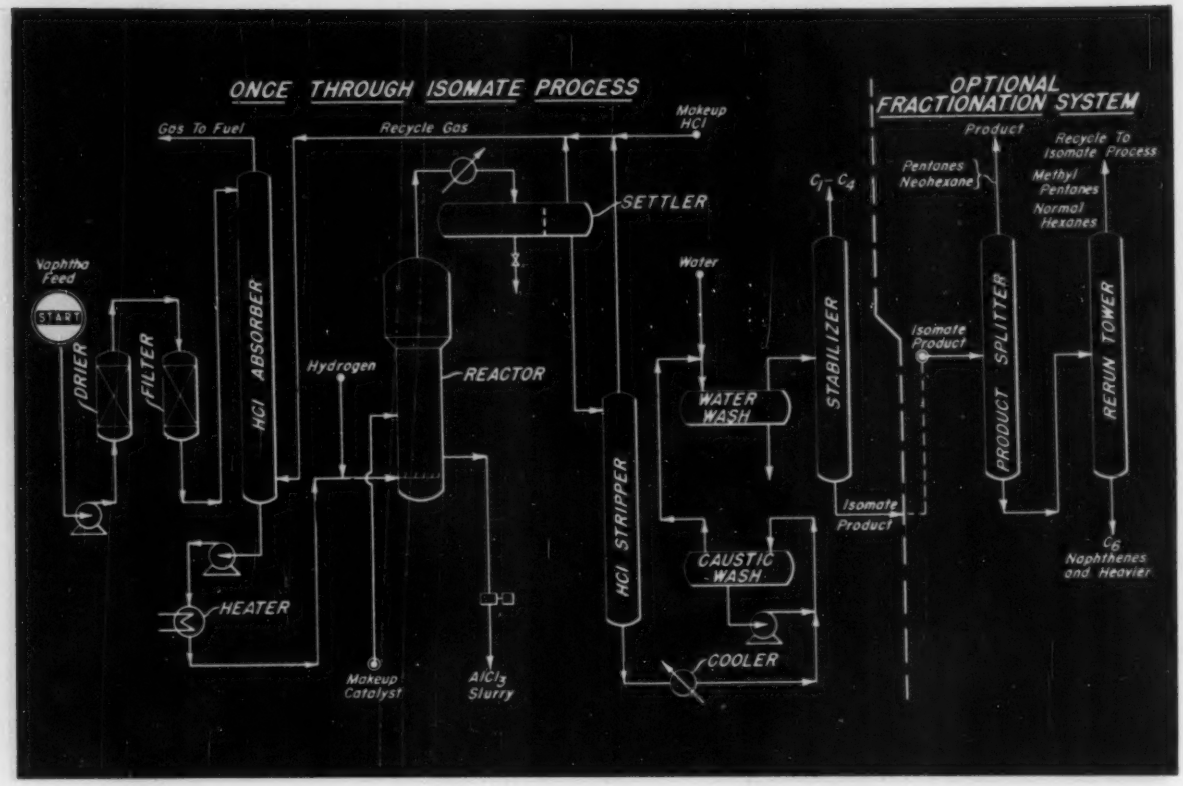
Operating Conditions: The process variables are: pressure, recycle gas rate, space velocity, and temperature. The reactor temperature is in the range of 650 F. to 850 F. and the pressure from 350 to 600 psig.

Yields: Typical yields and properties of products from Kuwait, Mid-Continent or natural pentanes and hexanes are shown below. When charging pentanes only the yields of isopentane will be approximately 99 vol percent.

Yield and Octane Data

	Kuwait*		Mid-Continent*		Natural Gasoline†	
MATERIAL	Feed	Product	Feed	Product	Feed	Product
Total C_5 and C_6						
Yield, Volume Percent	100.0	98.6	100.0	98.3	100.0	99.2
F-1 O.N.						
Clear	64.1	79.0	63.0	78.0	73.0	85.7
+ 3cc TEL/gal.	88.2	96.0	86.5	95.0	93.4	99.6
Isopentane Fraction:						
Yield, Volume Percent	45.0	45.0	34.5	34.5	58.5	58.5
F-1 O.N.						
Clear	74.4	92.0	72.9	92.0	79.2	92.0
+ 3cc TEL/gal.	95.8	105.6	94.5	105.6	98.0	105.6
Isohexane Fraction:						
Yield, Volume Percent	55.0	53.6	65.5	63.8	41.5	40.7
F-1 O.N.						
Clear	55.9	68.0	57.7	70.5	64.0	76.4
+ 3cc TEL/gal.	82.0	89.0	82.3	90.0	86.8	93.5

* Recycle of n-pentane and once-through on hexanes.
† Deisohexanizing facilities included.



Isomate—STANDARD OIL COMPANY (INDIANA)

Application: To increase the octane number of light virgin naphtha by isomerizing low-octane paraffins to high-octane, branched isomers. The process complements catalytic reforming by upgrading C_5 and C_6 fractions which are difficult to reform.

Charge: Hexanes and mixed pentane-hexane feeds.

Product: The octane number of Isomate product depends on whether once-through or recycle operation is employed. Leaded, Research octane numbers ranging from 95 to 106 (G.M. Extension Scale) are obtained. The product is an excellent blending stock because Research octane numbers correspond closely with motor and road ratings.

Description: The process may be designed for once-through operation (shown to the left of the vertical broken line) or product fractionation with recycle may be added if even higher octane-number products are required. The catalyst is an aluminum chloride-hydrocarbon complex promoted with anhydrous hydrogen chloride. Hydrogen gas is supplied to the reaction zone to suppress cracking and disproportionation and to maintain catalyst activity.

Dry feed, after picking up HCl gas in an absorber, is mixed with hydrogen and is introduced near the bottom of a tower reactor. Catalyst is added separately. Isomerization takes place in the liquid phase. Product goes overhead to a settler where hydrogen and some HCl are flashed and any entrained catalyst is separated. The product is then stripped of HCl, cooled, washed and stabilized. Gases from the settler and from the stripper are returned to the absorber for HCl recovery. In once-through operation, the stabilized product is blended directly into gasoline.

If product having a leaded, octane number above about 97 is desired, the stabilized Isomate product is fractionated to separate high-octane neohexane, diisopropyl and pentanes as overhead; the lower-octane bottoms are rerun in a separate tower and recycled for further isomerization.

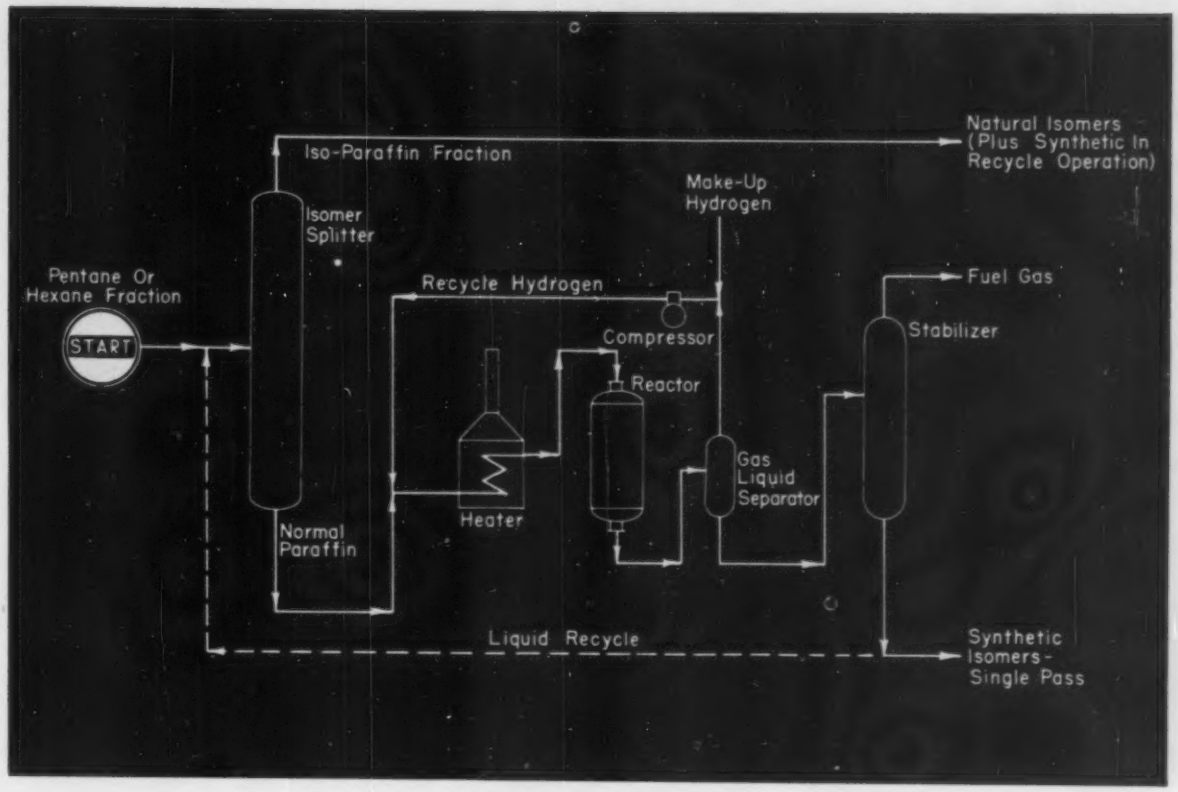
Operating Conditions: Reaction temperatures of about 240-250 F. Reaction pressure of about 700-800 psi.

Yields: See accompanying table.

Commerical Installations: During World War II, the Isomate process was used in two commercial plants to make aviation-gasoline blending stocks. Based on this commercial operating experience, the process is now being improved and adapted to the production of high-octane, light blending stocks for motor gasoline production.

	FEEDS		PRODUCTS		
			Hexane		Mixed Pentane-Hexane
Inspection	Hexane	Mixed Pentane-Hexane	Once-Through	Recycle*	Once-Through
ASTM Distillation, F.:					
Initial Boiling Point	142	112	115	102	102
10 Percent	148	123	130	109	115
50 Percent	150	133	149	118	128
90 Percent	155	149	180	121	154
Maximum	171	164	300	128	245
Gravity, °API	75.7	80.8	77.4	85.9	82.0
RVP, psi	4.9	8.9	7.1	11.2	10.6
F-2 Octane:					
Clear	63.5	68	79	92	81
+ 3 cc TEL	84.8	86	95	107	98
F-1 Octane:					
Clear	64	69	80	91	83
+ 3cc TEL	86	89	93	106	97

* After removal of gas and naphthenic product; also this example is for a 1.5 recycle ratio.



Isomerate—THE PURE OIL COMPANY

Application: To isomerize low-octane normal pentane and normal hexane to high-octane isomers.

Charge: Includes normal pentane and normal hexane from light straight-run naphthas and gasolines, natural gasolines, light catalytic reformate, light catalytic reformate raffinates, and hydro-treated light thermal, coker, or visbreaker naphthas.

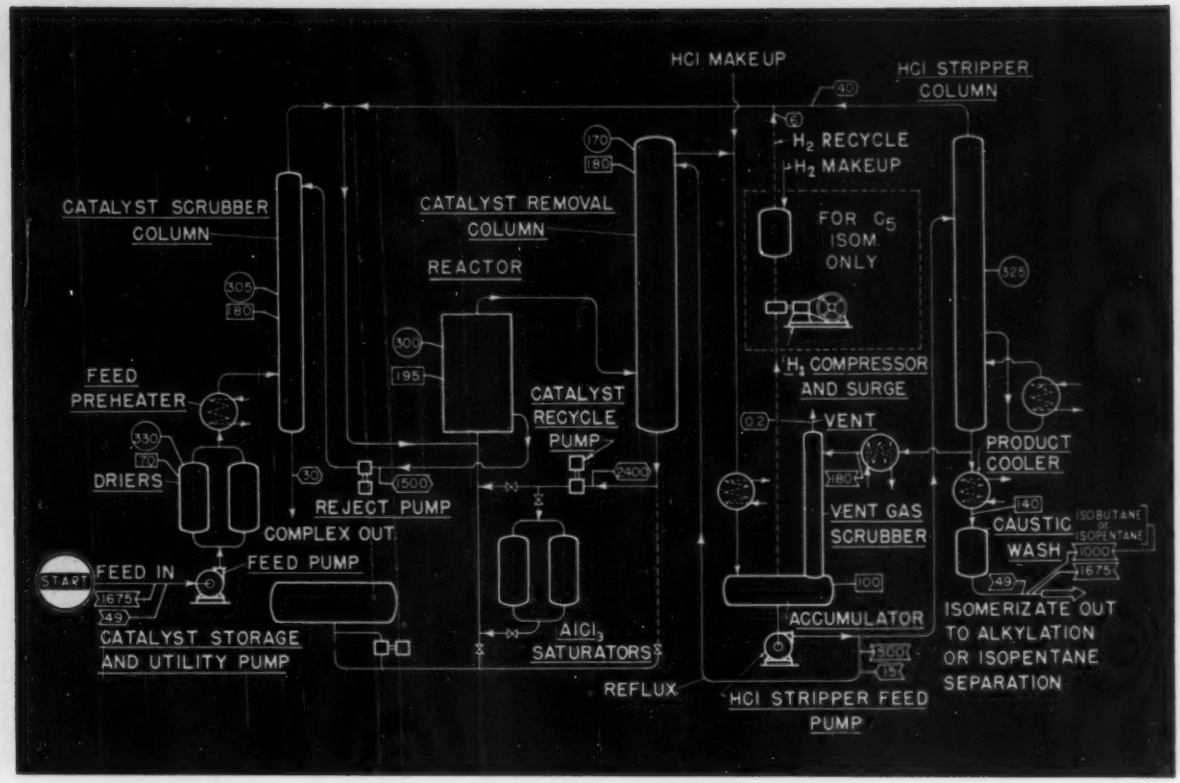
Product: The isopentane Isomerate research octane number (3 ml TEL) approaches 108.6. The actual value depends on the degree of product fractionation. The Isomerate produced from most straight-run naphthas (200 F. e.p.) has a research octane (3 ml. TEL) of 94 to 100 plus. This value depends on the feed composition, extent of recycling, and degree of fractionation.

Description: Normal pentane and normal hexane components of a light hydrocarbon feed stock are isomerized either jointly or singly on a once-through or recycle basis.

The flow diagram illustrates the isomerization section for a pentane or hexane fraction. The high octane isoparaffins are fractionated from the reactor charge and removed as product. The normal paraffins are isomerized. For the recycle operation, the stabilized Isomerate is returned to the reactor charge splitter for separation into isoparaffin product and normal paraffin for recycling.

Pentane and hexane fractions may be isomerized jointly or by a parallel arrangement of reaction sections. Feed preparation fractionators are arranged according to the requirements for once-through or recycle operations of the processing scheme employed.

Operating Conditions: High isomerization yields at conversions approaching equilbrium are obtained at mild reactor pressures of below 750 psi. and at temperatures of less than 800 F. The isomerization catalyst retains its high activity for a long operating period. The catalyst can be regenerated in place in the event it is fouled due to an operational upset.



Liquid-Phase Isomerization— SHELL DEVELOPMENT COMPANY

Application: For the isomerization of butane and pentane.

Description: The normal liquid paraffin (butane or pentane) is charged continuously at essentially atmospheric temperature through one of two feed dryers (used alternately and regenerated periodically), through a heater where the temperature is raised to about 180 F., thence through a packed catalyst-scrubber column and into the contactor. A liquid-liquid extraction of a small sidestream of the contactor catalyst with the feed takes place in the scrubber. The valuable active catalyst components pass back to the contactor in solution while the fluid inactive $AlCl_3$-hydrocarbon complex, which forms as a consequence of the small amount of side reactions, runs to the bottom of the column and is periodically drained off.

The butane with dissolved recycle HCl is then contacted in the reactor with a solution of $AlCl_3$ in molten $SbCl_3$. A relatively short residence time in the reactor is sufficient to achieve a high conversion—55 to 60 percent for butane and 60 to 70 percent for pentane. After phase separation from the catalyst in upper settling section of the reactor, the isomerizate flows to the catalyst-removal column for separation of dissolved catalyst by a simple fractionation. This recovered catalyst is pumped back to the reactor; the isomerizate is taken overhead, condensed, and pumped to the HCl stripper where the acid gas is removed and recycled to the reactor. The isomerizate, thus essentially freed of HCl, is given a caustic wash and sent to subsequent operations.

When isomerizing n-pentane, the reaction is effected in the presence of a small amount of hydrogen to suppress disproportionation reactions. The bulk of the hydrogen is recycled from the top of the catalyst column accumulator; however, some passes in solution to the HCl stripper and is recycled with the HCl.

The small amount of uncondensable gas that is formed is vented from the accumulator through a scrubber.

Operating Conditions: See Table 1.

Yields: See Tables 2 and 3.

Commercial Installations: Six installations.

Reference: PETROLEUM REFINER, vol 36, no 9, p 223 (Sept, 1957).

TABLE 1—Design Conditions

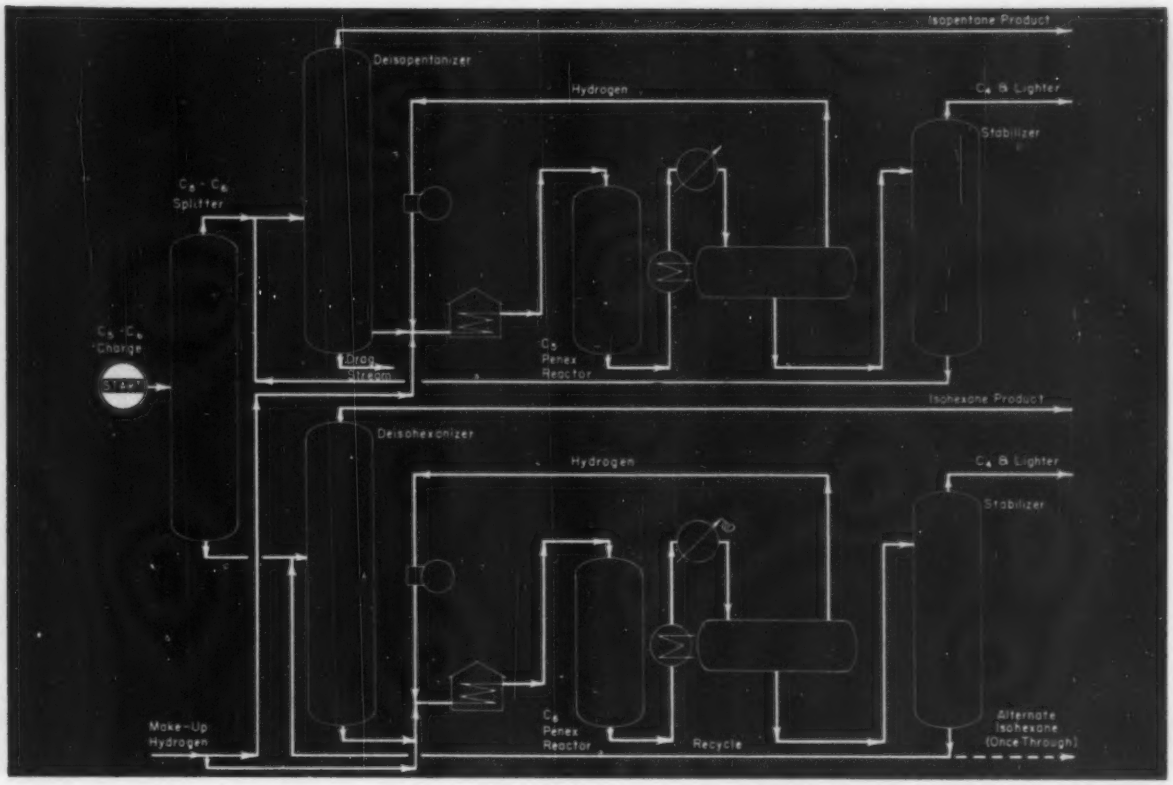
Process Conditions	Butane	Pentane
$AlCl_3$ content of catalyst, wt. %....	9–10	3
Temperature in contactor, °F.....	176–194	176–212
HCl content of feed, weight percent	5	5
Operating Pressure, contactor, psig..	300	300
H_2 partial pressure in contactor.....	.....	60 psi. minimum
H_2 concentration in feed, mole %...	.....	1.3

TABLE 2—Yield Data for Butane

Component, Volume Percent	Feed Stock	Single Pass Isomerizate
Lower boiling than butanes.....	0.0	<0.3
Isobutane.....	4.2	59.6
Normal butane.....	95.6	38.6
Isopentane.....	0.2	1.5
Hydrocarbons as $AlCl_3$ complex...	....	<0.1
Yield of isoparaffin.....	....	97

TABLE 3—Yield Data for Pentane

Component, Volume Percent	Feed Stocks	Single Pass Isomerizate
Butanes.....	0.0	0.6
Isopentane.....	6.1	65.5
Normal pentane.....	90.7	30.0
Heavier than normal pentane.....	3.2	3.8
Hydrocarbons as $AlCl_3$ complex...	....	<0.1
Yield of isoparaffin.....	....	97



Penex—UNIVERSAL OIL PRODUCTS COMPANY

Application: Improves the octane rating of pentane and/or hexane fractions from refinery naphthas and natural gasolines by isomerization over a specially prepared platinum-containing catalyst in the presence of hydrogen.

Charge: Pentanes, hexanes or a C_5-C_6 mixture. Ideally, a C_5 fraction is fed to pentane isomerization, and C_5 isomers are fed to hexane isomerization, but processing a mixed C_5-C_6 stream in a single reactor also is feasible.

Description: A typical simplified flow diagram for Penex isomerization of a C_5-C_6 mixture is shown which employs a splitter to achieve close separation between pentanes and hexanes. Hexane isomerization in this example illustrates the alternatives of once-through or recycle processing—the exact arrangements are chosen to best suit the needs of the individual refinery; pentane isomerization illustrates recycle processing only—the usual commercial application. Hydrogen is employed to minimize the formation of catalyst deposits and normally is recycled. Make-up requirements may be furnished from a Platforming unit or some other supply source.

Reaction conditions are considered mild in severity. Temperatures range from 500 to 900 F.; pressures from 300 to 1000 psi. Hydrogen consumption is insignificant. In C_5 isomerization the hydrogen requirement is about 40 scf/b, of which 10 scf/b is chemical loss and the balance is dissolved in the separator liquid product; in C_6 isomerization, chemical and solution losses are about 25 scf/b each. Highest yields of iso-compounds are obtained when pentanes and hexanes are isomerized separately, and when recycling of unconverted hydrocarbons is practiced.

Catalyst regeneration is not necessary; its life is long. Carbon steel construction is permissible because both catalyst and reaction products are non-corrosive.

Yields: Conversions approaching equilibrium are achieved in a single pass and recycling permits the achievement of virtually complete conversion. Typical yields from a mixed C_5-C_6 feed are shown in Table 1.

Economics: See Table 2.

Reference: *The Oil and Gas Journal*, vol. 55, no 20 p 142-46 (May 20, 1957).

TABLE 1

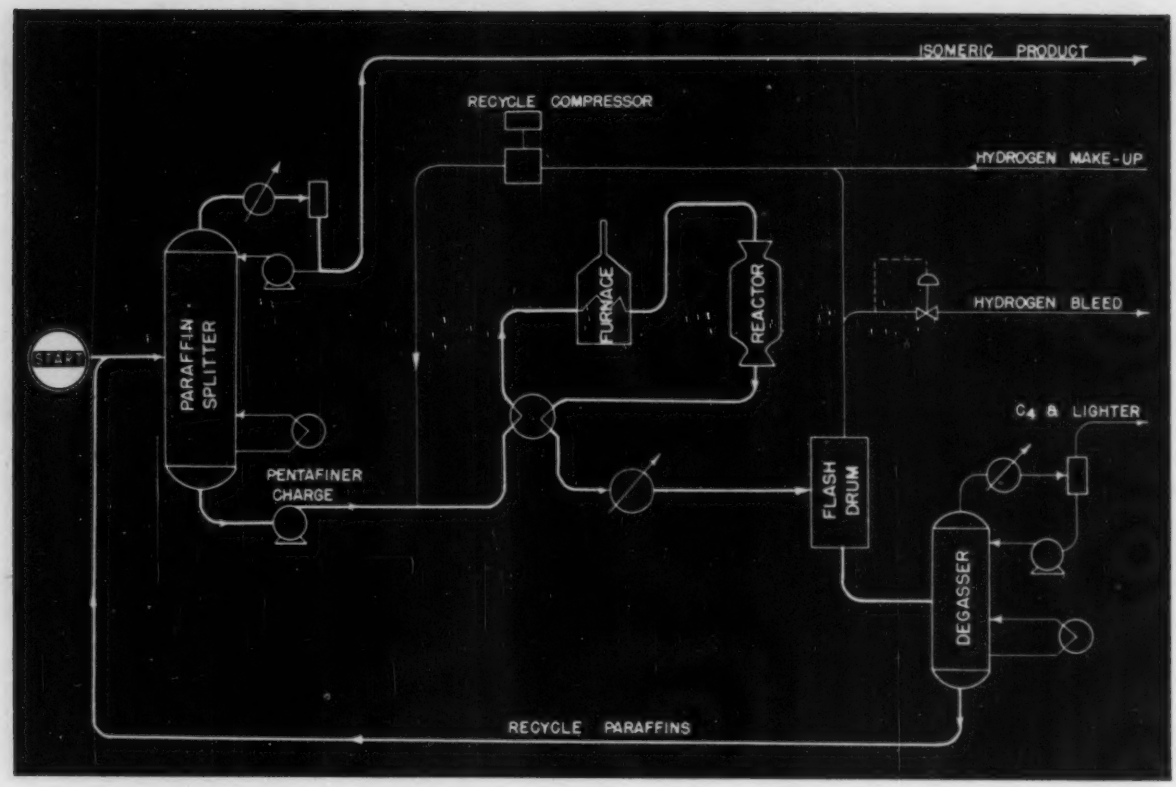
Component, Volume Percent	C_5-C_6 Feed	C_5-C_6 SPLITTER: Overhead to C_5 Penex	C_5-C_6 SPLITTER: Bottom to C_6 Penex	PENEX PRODUCTS*: C_5 Product	PENEX PRODUCTS*: C_6 Product
i-Butane	0.1	0.3	....	0.9	....
n-Butane	0.2	0.5	....	....	....
i-Pentane	20.2	50.4	0.1	94.2	0.1
n-Pentane	18.9	45.8	0.9	4.9	0.8
Cyclopentane	0.7	1.1**	0.5	....	0.4
Dimethylbutanes	5.5	1.8**	7.9	....	18.2
Methylpentanes	25.3	0.1**	42.2	....	58.5
n-Hexane	24.0	....	40.1	....	12.6
Methylcyclopentane	2.8	....	4.6	....	7.2
Cyclohexane	1.0	....	1.6	....	0.4
Heptane & heavier	1.3	....	2.1	....	1.8
	100.0	100.0	100.0	100.0	100.0
Yields, Vol. % reactor charge	....	....	....	99.0	98.2
F-1 Octane Number Clear	65.4	....	....	91.0	74.8
Plus 3 ml. TEL/Gal.	88.6	....	....	103.0	93.0

* Recycle operation.
** Assumed withdrawn as a drag stream from fractionator.

TABLE 2

	C_5-C_6 Splitter	C_5 Penex (Total Recycle)	C_6 Penex (Partial Recycle)
Fresh Feed, bpsd	6,464†	2,580	3,800
Isomerized Product, bpsd	.....	2,552	3,732
Unit Cost, Erected,* $	310,000	990,000	1,190,000
Operating Cost, ¢/Bbl.:			
Labor and Supervision	.....	7.4	3.3
Utilities	.....	17.5	11.3
Maintenance, Taxes and Insurance	.....	6.2	4.8
Catalyst Replacement	.....	2.0	3.9
Total	.....	33.1	23.3

* Catalyst inventory excluded.
† Includes 84 bpsd withdrawn as dragstream.



Pentafining—THE ATLANTIC REFINING COMPANY

Application: Increases the octane rating of low-boiling normal paraffins by selective isomerization. The catalyst promotes chemical equilibrium with insignificant losses to butane and lighter.

Charge: Feed stocks should be rich in normal pentane, hexane, or heptane. All three may be isomerized together, but highest once-through conversions are obtained with a separate reaction section for each.

Product: The reaction product requires only degassing before inclusion in finished gasoline. No rerunning, sweetening, or other treatment is required.

Description: The flow diagram illustrates operation on a mixture of pentane, hexane, or heptane paraffins. The normal paraffin is first separated from its isomers in a conventional fractionating tower. The bottoms product, rich in normal paraffin, is charged to the Pentafiner.

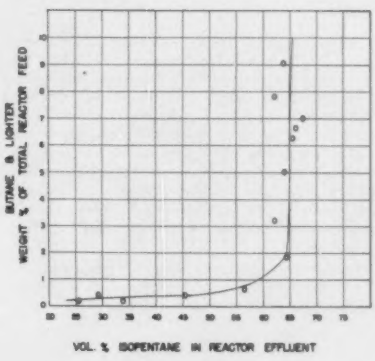
The normal paraffin is mixed with hydrogen recycle, preheated in exchange, and heated to reaction temperature in a furnace. The mixture is then passed downward through a single fixed bed of catalyst, wherein the temperature rises slightly. The reactor effluent is then cooled by exchange with the feed and condensed in a water cooler. The liquid separates from the recycle gas in a flash drum and then passes under level control to a simple degasser tower for removal of butanes and lighter. The gas from the flash drum is recycled.

After degassing, the equilibrium mixture is recycled to the splitter for separation of isoparaffins. A small amount of hydrogen must be continuously added to hydrogenate the products of cracking and sustain pressure.

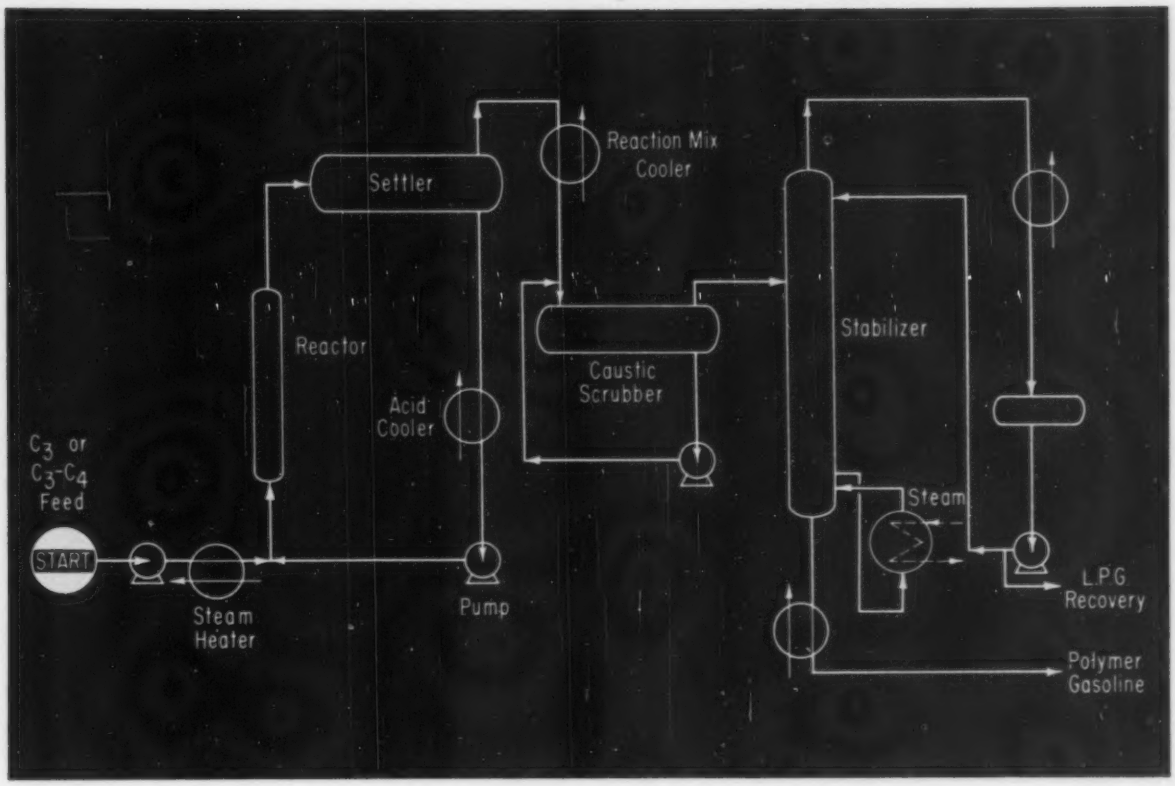
The catalyst is regenerated after long periods of operation with a dilute mixture of air and steam. Sulfur in the feed is handled by caustic washing to remove low-boiling mercaptans and hydrogen sulfide or by a conventional amine scrubber on the recycle gas.

Operating Conditions: Reactor temperature is 800-900 F., and operating pressure is in the range of 300 to 700 psig.

Yields: Typical once-through yields are illustrated by the plot of butane and lighter vs. percent isopentane in the reactor effluent. Ultimate yields of 95 percent isopentane are 98-99 volume percent of the fresh charge to the splitter.



Reference: PETROLEUM REFINER, vol 36, no 5, p 172, (May, 1957).



Bulk Acid Polymerization—CALIFORNIA RESEARCH CORPORATION

Application: To produce high octane polymer gasoline from olefins.

Charge: All types of olefin feeds, with olefin concentrations as high as 95 percent. The feed must be caustic and water washed to remove sulfur and nitrogen compounds.

Liquid phosphoric acid, commercially available from a number of suppliers in this country and abroad, is the catalyst. No support material is required.

Product: The polymer product has an F-1 clear rating of from 93 to 99. Inspections on a typical mixed propylene-butylene polymer are shown below.

Gravity, ° API	59.5
ASTM Distillation, ° F.	
IBP	132
10%	206
50%	271
90%	372
EP	439
Octane Number	
F-1 Clear	96.8
F-1 + 3 ml. TEL	101
F-2 Clear	82.5
F-2 + 3 ml. TEL	86.0

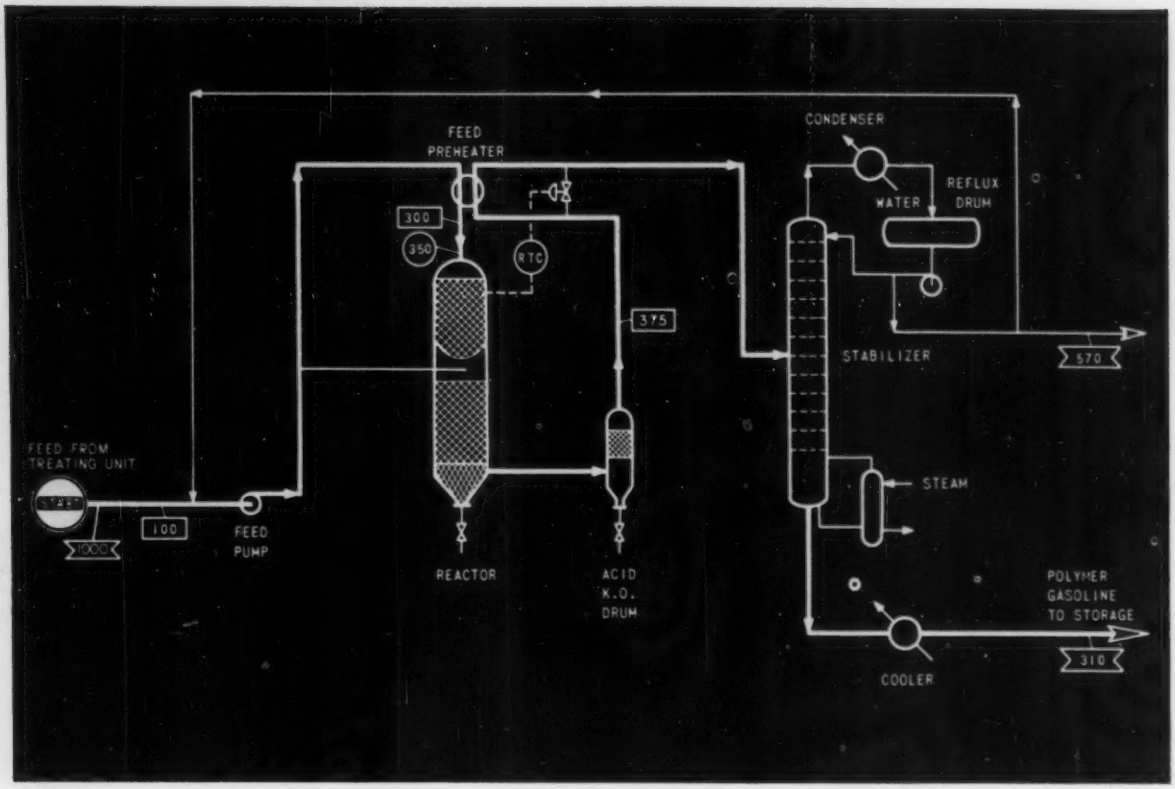
Gasoline polymer added to today's typical premium and regular gasolines maintains or improves road octane rating. For example, 20 percent gasoline polymer added to a 101.5 octane olefin aromatic base stock maintains the road octane. Similarly, 20 percent of the polymer added to a 98 F-1 paraffin aromatic base gasoline raises the road octane by 0.5 octane.

Description: The hydrocarbon feed and liquid phosphoric acid catalyst is brought into intimate contact in a small, high efficiency reactor. The reactor effluent is separated into acid and hydrocarbon in a conventional settler vessel, and the acid is returned to the reactor through a cooler. The product stream goes to recovery to yield polymer gasoline of the desired vapor pressure. Caustic scrubbing of the hydrocarbon from the settler is provided as protection for the recovery equipment from possible trace quantities of acid carryover. Caustic consumption is negligible. The acid stream which is returned from the settler to the reactor provides a high heat capacity "flywheel," so that temperature rise in the reactor is relatively small. Reactor temperatures can readily be controlled within narrow limits.

The small size of the reactor and the use of an all-liquid catalyst, without the requirement for loading and unloading solid catalyst support materials, means savings in site costs and in the plant. The process is characterized by a high operating factor and ease of maintaining high conversion of the order of 95-98 percent, with excellent temperature control without recycle. Investment costs in the recovery section are lower because of the lack of recycle requirement. Catalyst activity can be maintained by continuous addition of fresh acid and withdrawal of spent acid.

Commercial Installation: A 100-bpd plant has been operating in Richmond, Calif.

Reference: PETROLEUM REFINER, vol 37, no 5, p 173 (May, 1958).



California Polymerization—CALIFORNIA RESEARCH CORPORATION HYDROCARBON RESEARCH, INCORPORATED

Application: (1) To produce high octane polymer gasoline from olefins, or (2) to produce cumene from benzene and propylene.

Charge: The motor polymer process is equally applicable to total gas feed such as is obtained from cracking or reforming plants, or to a liquid stream containing propene or butenes, or mixtures of both. The feed is caustic washed for the removal of H_2S and mercaptans and water washed for removal of nitrogen compounds.

Product: The F-1 clear octane rating of the polymers is in the range of 93 to 99, the F-2 clear in the range of 80 to 85, and blending values in the order of 115 to 120.

Description: In the reaction section, part of the fresh feed, either liquid or vapor, is preheated to about 300 F. by exchange with reaction mix coming from the reactor and is introduced into the top of the reactor. Polymerization of olefins is highly exothermic; and the temperature is limited to a maximum of 375 F. by the introduction of the balance of the cold feed through quench points appropriately located in the reactor. Reaction mix from the bottom of the reactor flows through a small vessel packed with limestone for removal of traces of acid exchanges with the top reactor feed, then flows to the product recovery section.

To prepare the catalyst, fine mesh quarts is supported on larger size quarts in the reactor. The reactor is filled with phosphoric acid and the excess drained off. A thin film of phosphoric acid remains on the quarts surface. To regenerate, the reactor is washed with water, steamed, and dried. After filling with phosphoric acid and draining off the excess acid, the reactor is then ready to go back on stream. This procedure can be completed in about 30 hours. In liquid feed operations, a catalyst life of at least 100 gallons of polymer per pound of phosphoric acid is obtained.

Operating Conditions: The motor polymer process is carried out between 300 and 375 F. and at pressures from 150 to 600 psig. When the feed contains very high concentrations of olefins, a diluent (usually stabilizer overhead liquid) is added to provide sufficient heat capacity to absorb the heat of reaction.

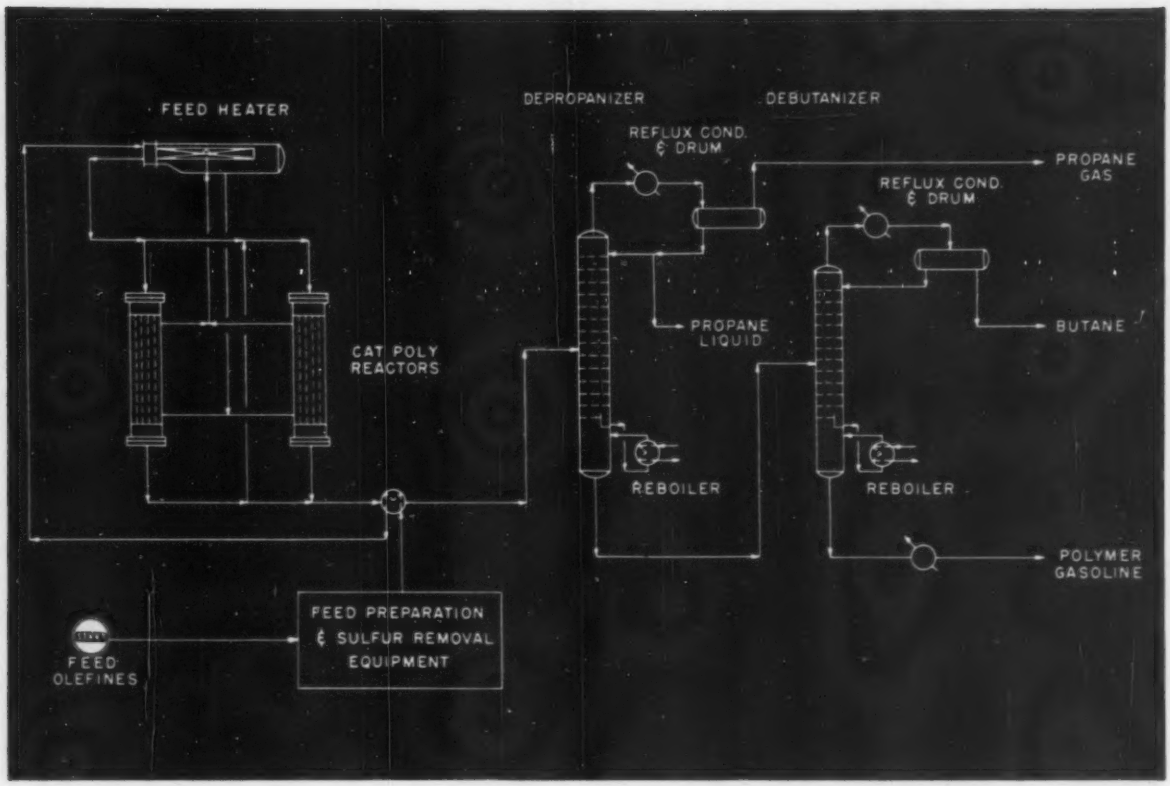
Yields: Conversions of 90 to 95 percent of the olefins are obtained. The table shows typical product properties:

	Propene[1] Polymer	Butene[2] Polymer
Gravity, °API	56.9	59.7
Reid Vapor Pressure, psi	0.5	2.0
Octane Number:		
F-1 Clear	93	99.0
F-1 + 3 ml TEL	99	Iso$^-$ + 0.18
F-2 Clear	80.5	81.0
F-2 + 3 ml TEL	85.0	84.2
ASTM Distillation, F:		
IBP	222	140
10 Percent	267	211
50 Percent	311	242
90 Percent	381	361
End Point	408	443

[1] Debutanized and rerun (95 percent rerun yield).
[2] Debutanized.

Commercial Installations: The first unit was built in 1937. There are now 37 units in operation throughout the world.

Reference: PETROLEUM REFINER, vol. 31, no 8, p 79 (Aug, 1952).



Polyco Catalytic Polymerization—THE M. W. KELLOGG COMPANY

Application: For chemically uniting propylenes and butylenes over a catalyst to produce a high-octane gasoline component.

Charge: The olefin-containing liquid stream of C_3 and C_4 hydrocarbons from a gas-recovery system provides a typical feedstock for this process.

Description: The feed is first treated to remove hydrogen sulfide and then washed with caustic to remove mercaptan sulfur. It is then heated to 300-400 F. and introduced into the reactor, which is kept at about 900 psig to maintain the material in the dense phase. Processing conditions may be altered depending on type of operation desired.

As the hydrocarbons pass through the reactor the olefins combine to form the polymers. The reaction is exothermic and the heat of reaction must be removed to provide control of catalyst temperature and to prevent the formation of heavy polymers. The reactor is essentially a heat exchanger with the catalyst in the tubes and a coolant in the shell. The coolant is usually boiling water, but can be circulating gas oil. Automatic control of reaction temperature is obtained by regulation of steam pressure or rate of oil circulation. Chamber type reactors are also used, the catalyst being supported on screens in a vertical chamber. In this type of reactor heat of reaction is removed by recycling a stream of liquid hydrocarbons from the depropanizer or stabilizer.

Reactor effluent is heat exchanged with incoming feed and proceeds to a stabilizer, or a fractionation system as illustrated, which produces high-octane polymer gasoline, and also streams of high purity propane and butane suitable for LPG sales.

Operating Conditions: There are three principal types of operation, depending on the feedstock:

- Codimer Operation, which applies to hydrocarbon feedstocks consisting essentially of C_3's. The operation usually is carried out at temperatures in the order of 300 F. The product, called codimer, is unsaturated, but when hydrogenated has a clear F-2 octane number on the order of 95 and is, therefore, a very acceptable component for aviation gasoline.

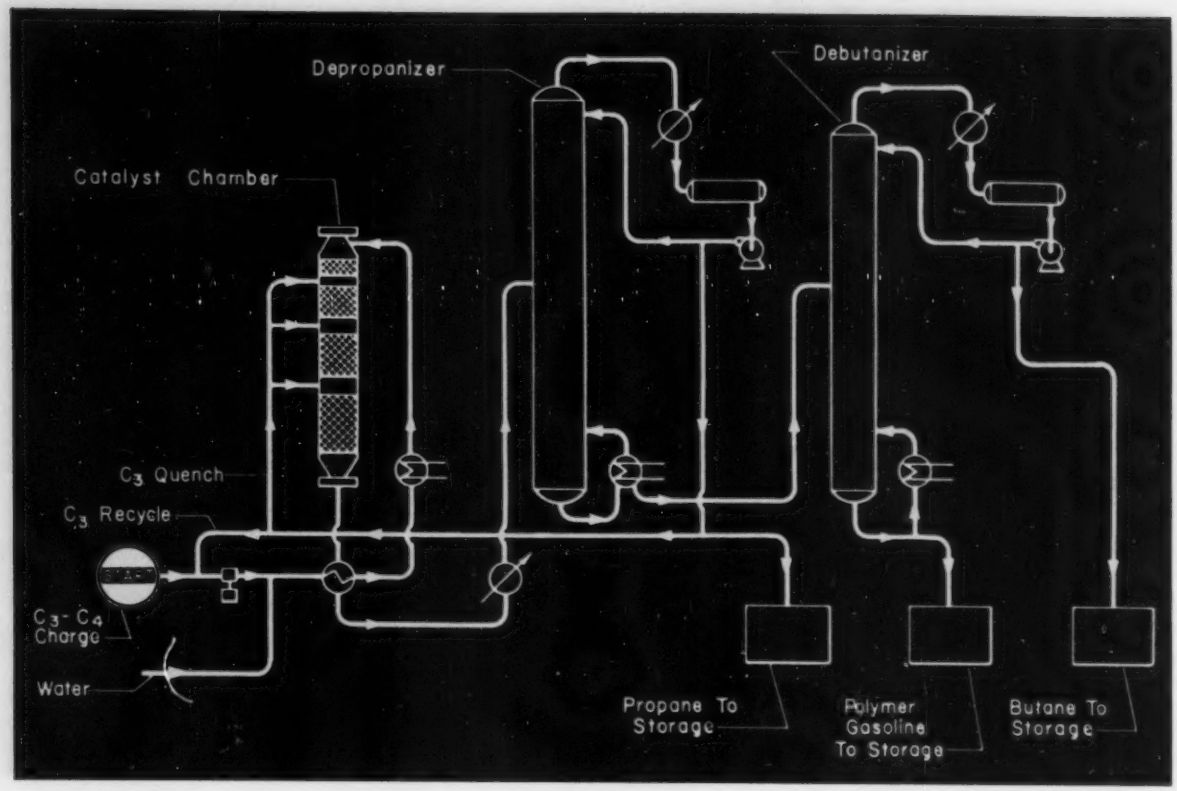
- Mixed C_3-C_4 Operation, which charges mixtures of propylene and butylenes. This feed stock is usually polymerized at approximately 375-400 F. The polymer is unsaturated and has a clear octane of about 83 F-2 O.N. and 96-98 F-1 O.N. Its blending value, however, is considerably over 100 by either rating method so long as the percentage in the blend does not exceed 10 or 15 percent.

- Propylene Operation, which applies to polymerization of propylene for motor fuels or production of tetramer. The operation is carried out at temperatures of approximately 350-425 F. and a pressure of about 700 psig. Conversions run approximately 80 percent with product octanes of 80 F-2 O.N. and 92 F-1 O.N. (clear). Tetramers production from propylene is accomplished by recycling light polymer.

The polyco catalyst is based upon copper pyrophosphate. It has a normal life of 100-200 gallons of polymer per pound of catalyst.

Yields: The table below furnishes typical results for various types of operation:

	Codimer Operation	Mixed C_3-C_4 Operation	Propylene Operation
Conversion, Percent of Olefin	80	90	70
F-2 Octane No.—Clear	95	83	82
F-1 Octane No.—Clear	...	96-98	92
RVP of Polymer, psi	2.0	2.0	2.5
IBP of Polymer, F	148	170	128
EP of Polymer, F	421	431	420
Gravity of Polymer, °API	60.4	60.1	59.8



Solid Phosphoric Acid Condensation—UNIVERSAL OIL PRODUCTS COMPANY

Application: For converting propylene and butylenes to high octane gasoline blending agents; to polymerize pure propylene, or butylenes, into valuable chemical polymers; and to alkylate olefins with aromatic hydrocarbons in petrochemical syntheses.

Products: See table. The products include the polymerization of propylenes to produce a full-boiling motor polymer and to produce dimer, trimer, tetramer and pentamer; the polymerization of a refinery mixture of propylene and butane-butylenes; the alkylation of propylene with benzene to yield cumene, and alkylation of ethylene with benzene to form ethylbenzene. The process is not limited to these compounds, however.

Description: The process consists of bringing the olefin-containing feed stream in contact with the catalyst, when polymerization reactions are desired, at temperatures ranging from 350 to 435 F. and pressures from 400 to 1,200 psig. Alkylation conditions range in temperatures from 400 to 600 F. and pressures from 400 to 900 psi.

The catalyst is UOP Solid Phosphoric Acid. This highly active material is a pelletized and calcined mixture of phosphoric acid with kieselguhr. The reaction is exothermic but adiabatic conditions must be maintained for optimum yields of desired products and good catalyst life.

Two types of reactors are in use: (1) the tubular type in which the catalyst is packed into tubes surrounded by water jackets for temperature control, and (2) the more commonly used chamber type wherein the catalyst is divided into beds, between which a quench of cold reactor effluent is used to help maintain temperature, while a recycle of essentially paraffinic hydrocarbons is injected into the feed as a diluent for the same purpose.

The flowsheet shows the arrangement of equipment for the polymerization of propylene or butylenes and their mixtures to produce motor polymers. When charging propane-propylene to make a motor polymer the debutanizer is not required. The synthesis of dimer (C_6 olefins), trimer (C_9 olefins) tetramer (C_{12} olefins) requires slight operation modifications and an additional fractionator as a re-run column.

Yields: Motor polymer made from C_3C_4 olefins is recovered in yields normally corresponding to 90-97 wt.-% on charge. Propylene motor polymer yields vary from 1 to 25 liquid volume percent of total polymer in the production of tetramer from propylene. The cumene yield is approximately 96 vol.-% of the propylene-benzene feed.

PROPERTIES OF PRODUCTS

	C_3 Motor Polymer	C_3-C_4 Polymer	Tetramer	Cumene
R.v.p., lbs.	4.4	9.2	0.0	0.0
Gravity, °API	59.5	66.1	51.0	32.1
ASTM Engler Dist:				**ASTM Aromatic Dist.**
Initial Boiling Point, F	136	96	353	301
5 Percent	....	130	....	302
10 Percent	228	149	361	302
30 Percent	258	201	....	302.5
50 Percent	**276**	**228**	**371**	**303**
70 Percent	292	263	....	303
90 Percent	338	348	397	303
End Point	420	422	450	304*
Research octane with 3 ml. TEL	99.5	100	....	....

* Dry point.

Reference: Jones, E. K., "Polymerization of Olefins from Cracked Gases," *Advances in Catalyst*, vol VIII, p 219, Academic Press, Inc, New York (1956).

Solvent Refining

SOLVENT REFINING methods are used primarily to extract (and dewax) lube oil fractions and to prepare feed stocks for catalytic cracking. By this method, hydrocarbon mixtures are separated on the basis of their relative solubilities without regard to volatility or the possibility of thermal decomposition. The processes are physical in nature, the chemical character of the various hydrocarbons remaining unchanged.

Lube Oils: In lubricant manufacturing the good properties of paraffinic materals are sought. The development of solvent processes has to a large extent eliminated the sharp distinctions once made between different crude oils on the basis of their suitability for lubricating oil manufacture. Now the undesirable aromatics may be removed so that crude oils are evaluated on the amount of lubricating oil of specified quality which they will yield.

Dewaxing: The waxes in lube oil stocks are separated to produce finished lubricants with low pour points and also to recover wax either as a salable product or as stock for further processing. Solvent dewaxing is favored over the older method.

Deasphalting: Low carbon residue is desirable in feed stocks charged to catalytic cracking units. Here solvent refining competes with other feed preparation processes, such as vacuum distillation, visbreaking, coking, etc. Advantage of solvent refining is that it avoids high temperatures that lead to thermal decomposition of the feed stock.

Treating Processes

TREATING PROCESSES are essential to petroleum refining, although they have an accessory relation to the basic scheme of converting crude oils to gasolines and fuels. Treating is used to make feed stocks suitable for processing to their best advantage, and it finishes products to meet quality standards. As quality requirements become more stringent, investment in equipment and efforts devoted to operating and maintaining such processes reach sizable proportions.

Crude desalting is a treating method employed at the very beginning of a crude processing scheme. The large majority of crudes are contaminated with salt water, either as an emulsion with the oil or in free form.

Caustic washing is a widely used means of treating gasoline products for removal of hydrogen sulfide and mercaptans. Several processes use additional compounds in the caustic solution to promote reaction of the solution with the mercaptans. Dualayer, Mercapsol, and Solutizer processes use acid oils and phenolic materials for this purpose. Unisol uses methanol to improve extraction.

Some processes are designed to handle those situations where the caustic or other treating solution is reluctant to separate from the product. These are Electrical Distillate Treating and Distillate Treating.

Gas treating may be practiced with such processes as Girbitol or Glycol Amine Gas Treating. They are employed usually to remove sulfur from gases charged to polymerization units.

Percolation Filtration and Continuous Contact Filtration are two processes for improving color and odor of lube oils. The first contacts the oil in a fixed bed of absorbent. Regeneration is done in place. In the latter process, the absorbent is added to the charge to form a slurry which passes through the system. Afterward, the absorbent is dropped out of the stream and is regenerated.

Additives are a form of treating which is not represented in this handbook. Deactivators are used to tie up copper compounds so that they will not affect the gum and color stability of a product. Other additives promote oxidation of mercaptans to disulfides, and these are used to relace the more expensive sweetening processes.

Hydrodesulfurization is fast becoming a major process for removing sulfur compounds and other objectionable materials from refinery streams. The hydrogen for the process is readily available as a by-product from the many gasoline reforming processes being installed. In some cases, refiners are finding it worthwhile to install separate plants which crack methane and other light materials to produce the hydrogen needed. Two new processes added in this issue of the Handbook are the Hydrodesulfurization process of the M. W. Kellogg Company (Page 285) and the Ultrafining Process of the Standard Oil Company-Indiana (Page 288).

A comprehensive review of this type of treating is given in the article by Herbert Kay on "What Hydrogen Treating Can Do," PETROLEUM REFINER, vol 35, no 9, pp 306-318 (Sept, 1956).

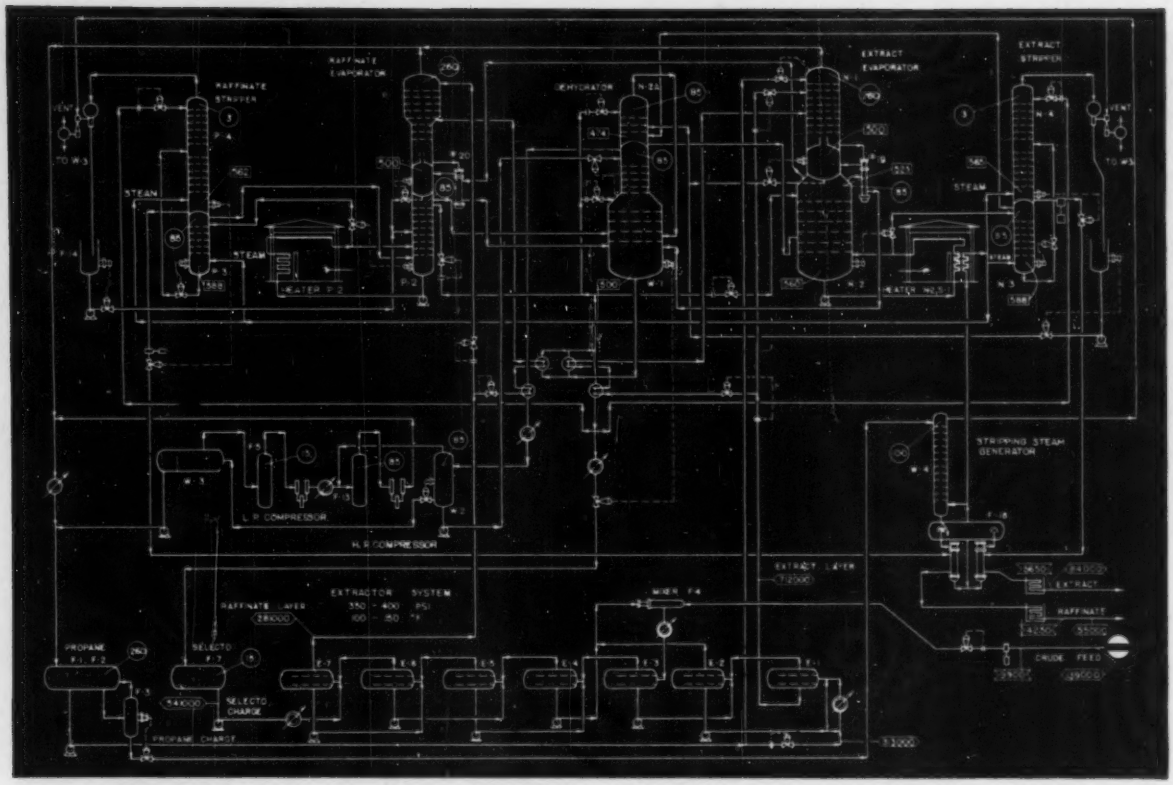
Other Refining Processes

ALONG WITH THE necessity of converting crudes and gases into products, there is the need also to separate and recover hydrocarbons as they already exist in a refinery crude or field stream. As there are many variations of these processes, only a few are represented here.

Crude distillation is a fundamental operation in any refinery. It is important primarily because it is the simple separation of a crude charge into discrete components.

Light hydrocarbon recovery is required within a refinery to get maximum utilization of gaseous materials. It permits cracked and reformed gases to be separated into more valuable fractions for special processing.

Petrochemicals are getting a growing portion of the chemical market. One of the processes (Page 310) which can be used for the production of butadiene is included with modifications for producing the butylene needed for alkylation feed. Because of the great interest in other petrochemicals, the processes which deal with their production are combined in a separate handbook. Our last publication of the Petrochemical Handbook appeared in the November, 1957 issue of the PETROLEUM REFINER.



Duo-Sol—THE MILWHITE COMPANY, INCORPORATED

Application: For the extraction of high viscosity index, light color, low carbon residue lubricants from any residual or distillate base stock.

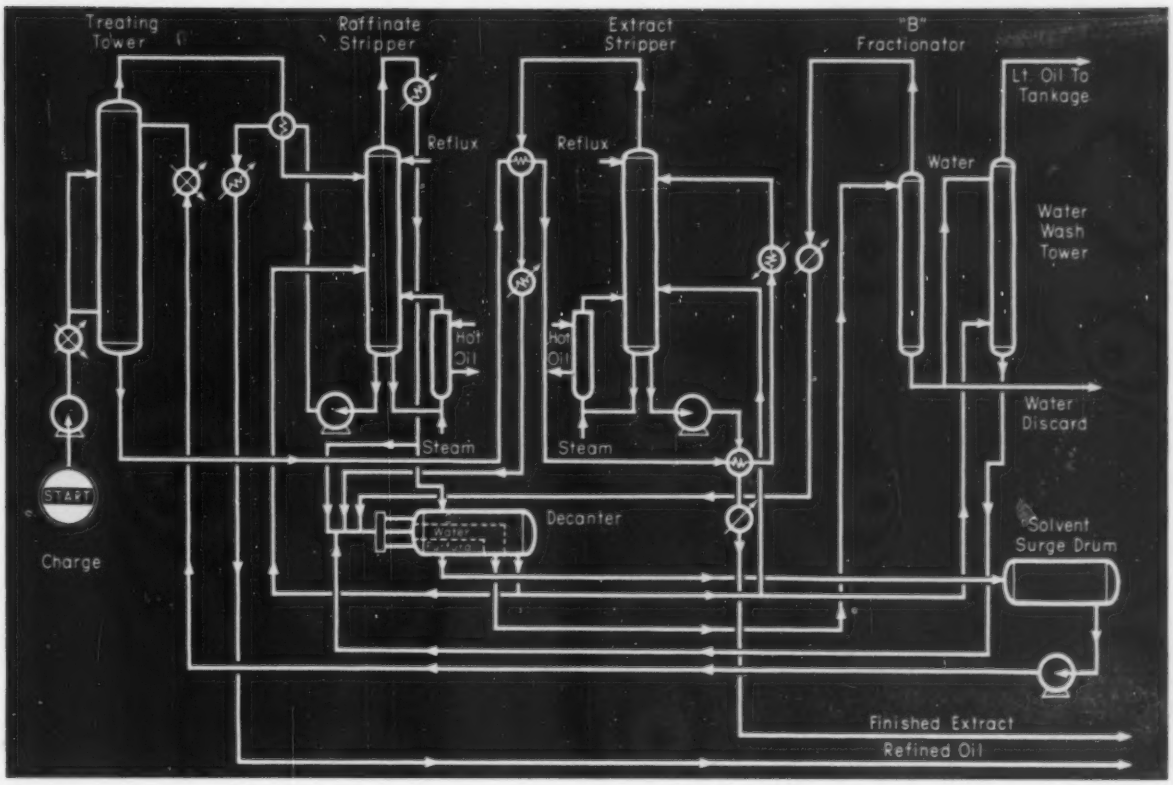
Description: The Duo-Sol process of solvent extraction is exclusive in its application of two solvents acting simultaneously and countercurrently on a charge stock introduced in the center of the extraction system. For maximum extraction efficiency, the countercurrent extraction is carried on in seven separate stages, identified as E-1 to E-7 on the flow diagram. The solvents employed, both of which are frequently refinery by-products, are propane which has affinity for raffinate and Selecto (a blend of cresol and phenol) which preferentially dissolves asphalts and undesirable aromatics, naphenes and color bodies. In operation, the propane is charged into the E-1 end of the extraction system and Selecto into the E-7 end. In each extractor, the propane-raffinate leaves the top of the extractor vessel and passes to the next higher numbered stage, while the Selecto-extract is withdrawn from the bottom of each stage and pumped to the next lower numbered stage. Charge stock is generally admitted into E-3, together with raffinate phase from E-2 and extract phase from E-4. Raffinate progressing from E-3 to E-7 is treated in each stage with less diluted, more effective Selecto and extract from E-3 is stripped of all desirable constituents by propane in stages E-2 and E-1.

The solvents propane and Selecto are removed from the extract and raffinate layers by distillation in raffinate and extract evaporators P-1—P-2 and N-1—N-2, which consist of an upper section for higher pressure propane evaporation, and a lower section of the same vessel for evaporation of Selecto at low pressure. The final traces of Selecto are removed by a steam stripping in towers P-3, P-4, N-3, and N-4. This steam is removed from the distillation system as a constant boiling mixture at the top of tower W-1. After condensation and decantation the water containing Selecto is pumped to the propane charge tank to reduce the Selecto content to approximately two percent; from here it flows to tower W-4. Steam overhead of W-4 containing Selecto is employed for vacuum jets, while the steam obtained from the steam drum (F-19), essentially Selecto-free, is employed after superheating for the final steam stripping in the vacuum towers P-4 and N-4.

Yields: Typical extraction results are tabulated below:

	East Texas-Louisiana Residuum	San Joaquin Long Residuum	East Texas Distillate	Van Zandt Long Residuum	Iraq Long Residuum
Charge Stock:					
Gr. ASTM	15.2	14.9	26.2	17.4	14.8
Vis. @ 210° F. SUS	760	257	47.4	179	194
V.G.C.	.876	.893	.839	.879	.899
Flask °F.	595	470	420	435	420
Raffinate—Dewaxed:					
Gr. ASTM	26.5	29.3	29.9	27.5	27.6
Vis. at 210° F. SUS	143.3	61.0	48.0	64.4	54.2
V.G.C.	.809	.080	.811	.818	.822
V.I.	95	94	95	98	100
Pour	0	0	0	0	0
Color ASTM	8	4¼	2¾	5	3½
Conradson Carbon	.4	.1	.02	.25	.25
Duo-Sol Yield:					
Percent by Volume	43.6	34.7	73.0	60.9	55.0
Extract:					
Specific Gravity	1.026	1.0177	1.000	1.053	1.073

Commercial Installations: Nineteen.



Furfural Extraction of Gas Oils—TEXACO DEVELOPMENT CORPORATION

Application: For the solvent extraction of diesel fuel oils, burning oils and cracking stocks to remove materials having low cetane number as well as such undesirable materials as unstable, acidic, sulfur, organo-metallic and nitrogen compounds.

Product: The resultant treated oils have a higher cetane number and show a marked degree of improvement in engine cleanliness, improved burning qualities and greatly reduced sulfur, nitrogen and metals content.

Description: This process for the extraction of gas oils is an outgrowth of the Furfural refining process which is widely used for refining lubricating oils.

The extraction temperatures and furfural treating ratios for gas oils are generally lower than when refining lubricating oil stocks. The principal difference between these two processes, however, lies in the equipment for the recovery of furfural from the raffinate and extract solutions.

Following an azeotropic distillation, solvent-free raffimate and extract streams are taken from the base of the respective strippers, while the overhead vapors from these columns comprising an azeotropic mixture of oil, water and furfural are condensed and conducted to a decanter. Three liquid phases form in this decanting type of accumulator and all three of the components are present in each phase. The heaviest phase is predominantly furfural which is returned to the solvent circulating system. The intermediate phase is predominantly water which is charged to the water removal equipment from which solvent-free water is withdrawn. The overhead vapors are returned to the system for further separation and recovery of the oil and furfural. The lightest or oil-rich phase is pumped to a tower in which the furfural is extracted from the oil with water. The percentage of light oil to be recovered in this way is dependent upon the initial boiling point of the gas oil charging stock, varying from a negligible percentage for a stock with an initial boiling point of 500 F. or higher to about 3 percent when processing a stock having an initial boiling point as low as 420 F.

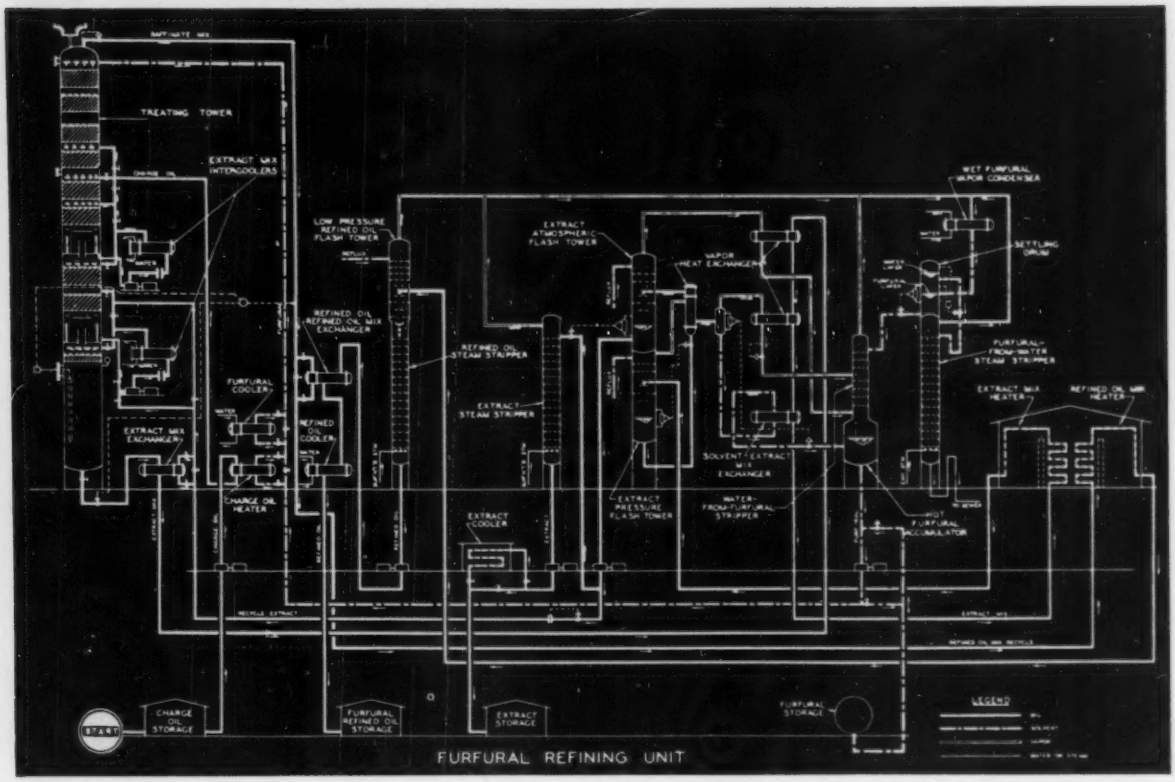
Adjustments can readily be made to permit the use of furfural containing a small percentage of oil and water.

This process is characterized by low solvent requirements which range from 25 percent of the charge oil when extracting a cycle gas oil stock for re-charging to a catalytic cracking unit to about 40 percent for a catalytic gas oil stock extracted for the production of high quality diesel fuel or furnace oils and to about 80 percent when processing virgin gas oil stocks for the production of fuels, burning oils or cracking stocks.

Yields: The yield of product raffinate is dependent upon the nature of the charge stock and the degree of quality improvement desired. For example, when extracting a virgin gas oil derived from West Texas crude to a raffinate yield of 82 percent, the sulfur content was reduced from 1.12 to 0.49 percent, while the cetane number was increased from 53.2 to 62.9. Similarly, in the extraction of a catalytic cycle gas oil from Middle East crude oil, the sulfur content was reduced from 1.39 to 0.39 percent and the cetane number increased from 44.8 to 62.5 with a raffinate yield of 78.9 percent.

Commercial Installations: Seven.

Reference: PETROLEUM REFINER, vol 29, no 9, p 196 (Sept. 1950).



FURFURAL REFINING UNIT

Furfural Refining—TEXACO DEVELOPMENT CORPORATION

Application: To extract undesirable components from petroleum lubricating oil stocks in order to produce oils of high quality.

Product: The raffinate or refined oil product has greatly improved temperature viscosity characteristics and contains all the desirable lubricating oil components present in the charge stock.

Description: In operation, the untreated oil is introduced into a continuous counter-current extractor at some midpoint and at a predetermined temperature. The temperature of the furfural which enters near the top of the extractor depends largely upon the miscibility relationship between the furfural and the oil being refined. A substantial temperature gradient is maintained between the top and bottom of the tower by indirect, external water coolers. Extraction generally is accomplished by passing the furfural in dispersed phase downward over raschig ring nests through the prevailing oil phase.

The extraction efficiency can be maintained at a high level by the controlled recirculation of the material extracted. The recirculated extract serves to enrich the furfural phase with the more soluble material and thus to displace from solution the last remaining traces of cycle oil which joins the rising oil phase being refined.

The furfural refining unit represented in the accompanying flow diagram comprises an extraction or treating section, sections for the recovery of furfural from the refined oil and extract solutions respectively, water removal facilities, process surge tanks and pumping equipment. Because of its stability over a wide range of operating conditions, furfural lends itself to a variety of methods of recovery.

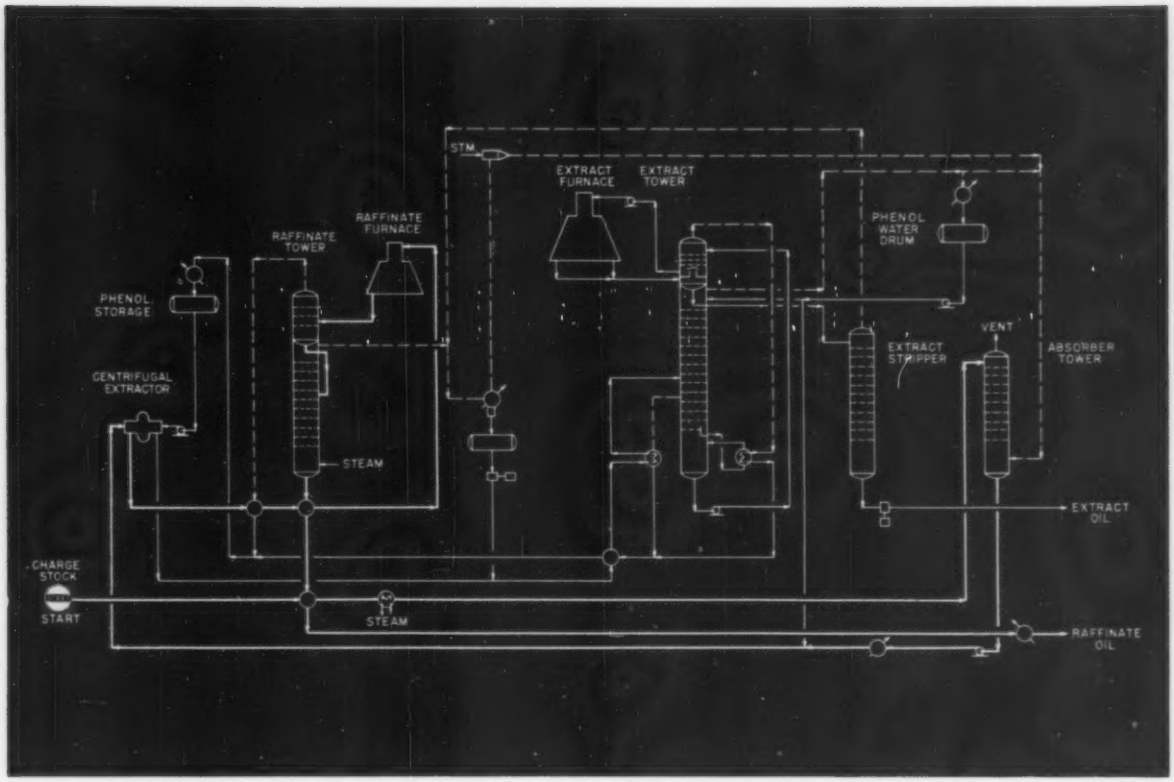
Furfural has a high solvent power for those components of petroleum which are relatively unstable to oxygen as well as other undesirable materials including color bodies, resins, carbon-forming constituents and sulfur compounds.

Yields: The operating conditions employed and the yields of raffinate obtained depend upon the nature of the charge stock and the degree of refining desired. Data of just a few of the many stocks typical of those processed for lubricating oil production are shown below:

Crude Source	East Texas	East Texas	Oklahoma City
Grade	Light Neutral Distillate	Deasphalted Bright Stock Residuum	Intermediate Viscosity Distillate
Charge Oil:			
Gravity, °API	28.3	23.1	25.4
Viscosity, SSU/210 F	41.0	132.6	69.3
Carbon Residue, percent	0.07	1.40	0.52
Raffinate:			
Gravity, °API	32.5	29.6	30.9
Viscosity, SSU/210 F	40.4	102.3	58.4
Carbon Residue, percent	0.01	0.20	0.03
Yield, percent by volume	85.0%	60.0%	76.9%
Dewaxed Raffinate:			
Gravity, °API	29.8	27.2	29.7
Viscosity, SSU/210 F	43.0	140.6	63.2
Viscosity Index	96.0	94.1	96.0
Pour Point, °F	20	0	0
Extract Gravity, °API	8.0	13.9	9.5

Commercial Installations: Fifty-five units. In addition, 2 units are under construction or being designed.

Reference: *Industrial and Engineering Chemistry,* vol 40, no 2, p 220 (Feb, 1948).



Phenol Extraction—THE M. W. KELLOGG COMPANY

Application: For improving viscosity index, color and oxidation resistance, and for reducing the carbon and sludge-forming tendencies of lubricating oils.

Charge: Raw lubricating oils of all viscosities, both distillates and bright stocks, from crudes of any type. Either waxy or dewaxed oils may be treated.

Product: Stable, light colored neutrals and bright stocks meeting the most rigid viscosity index specifications.

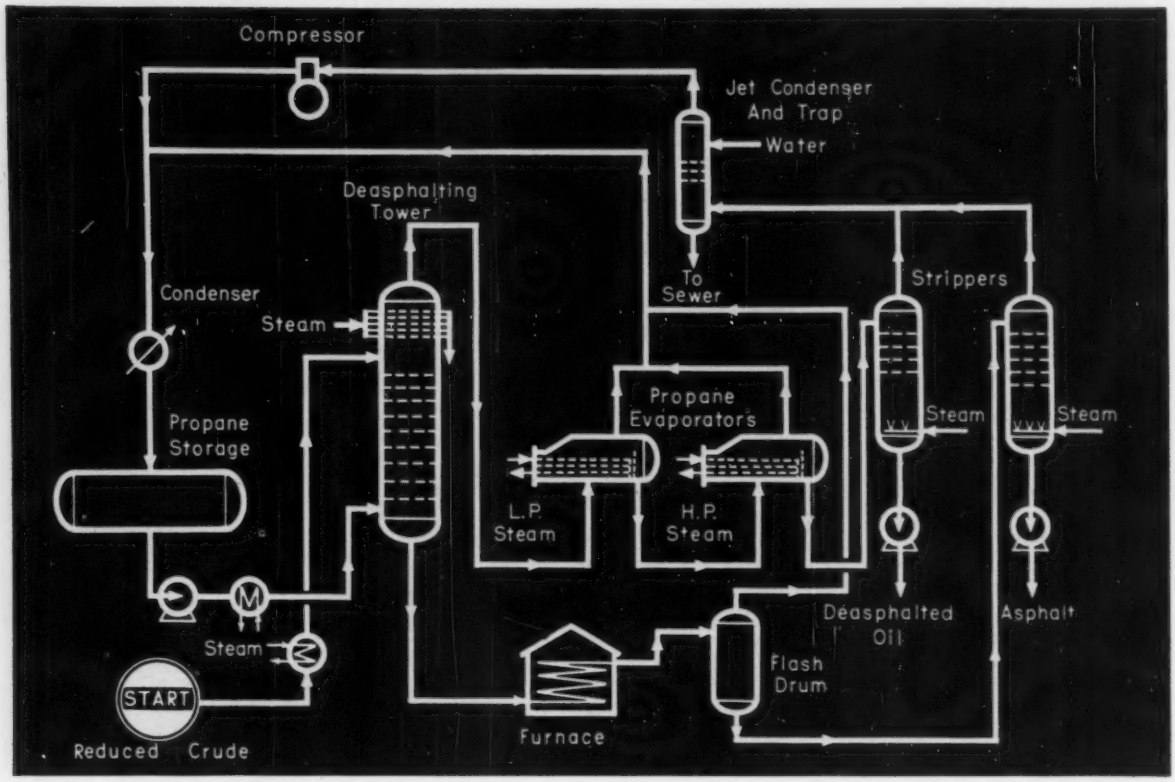
Description: Feed stock flows first through a phenol absorber tower to recover the small amount of phenol from steam being discharged from the plant. The feed is pumped from the absorber to the centrifugal extractor. Raffinate phase leaves the centrifugal extractor and, after heating, is flashed into the evaporator section of the raffinate tower. Phenol vapor from this section flows to a condenser and storage tank. The raffinate oil flows down to a section in which it is steam-stripped free of solvent and withdrawn as bottoms to storage. Steam and solvent vapors flow from the stripping section to vacuum equipment.

The extract phase from the centrifugal extractor is pumped through heat exchange to enter a drying tower, in which all water is removed as a phenol-water azeotrope. This vapor is condensed and enters the phenolic-water drum. Dry extract solution is pumped from the bottom of the phenol tower to a top evaporator section in which a portion of the phenol is flashed. The remaining extract solution is pumped from the evaporator section through a furnace coil. Extract oil flows from the evaporator section to a steam stripper in which the last traces of solvent are removed and then to storage.

Yields: The accompanying table illustrates typical yields and product inspection for several stocks.

	Deasphalted East Texas Residue	West Edmond SAE 40 Stock	Deasphalted Van Zandt Residue
Solvent/Oil Ratio Volume	3.0	2.13	3.48
Treating Temperature—F	245	201	200
Raffinate Yield—Volume Percent	64.5	88.2	59.3
Inspections-Untreated Oil:			
Gravity—°API	23.0	28.3	21.2
SSU Viscosity @ 210 F	159.0	77.4	180.1
Color ASTM	5	3	7
Carbon Residue, Conradson, Weight Percent	1.6	0.16	2.58
Dewaxed (Zero Pour) Viscosity Index	59	81	.....
Raffinate Inspections:			
Gravity—°API	29.0	30.2	27.3
SSU Viscosity @ 210 F	110.7	72.3	136.6
Color ASTM	4½	2—	6
Carbon Residue, Conradson, Weight Percent	0.26	0.04	.....
Dewaxed (Zero Pour) Viscosity Index	94	93	101.4

Commercial Installations: There are a total of 24 foreign and domestic units in operation or under construction.



Propane Deasphalting and Fractionation—THE M. W. KELLOGG COMPANY

Application: For separating asphalts or resins from viscous petroleum fractions finished into cylinder stocks, bright stocks and aviation lubes. The process may be modified to segregate heavy or medium neutral fractions by extraction with liquid propane rather than by distillation. By suitable choice of conditions close-cut resin fractions (Propane Resin Fractionation) and specification asphalts may also be produced.

Charge: Vacuum reduced crude of appropriate length. When also separating a heavy neutral fraction by Propane Fractionation the reduced crude charge is proportionately "longer" than when only separating between bright stock and asphalt.

Product: Deasphalted oil which, if produced from reduced crude of proper length, is normally of specification color and carbon residue after only solvent treating and dewaxing. Heavy neutrals produced by propane fractionation are markedly superior in physical properties to those from vacuum distillation.

Description: The feed is brought to extraction temperature by exchange with exhaust steam or cooling water and charged to the deasphalting tower. Liquid propane, introduced near the bottom of the tower, is contacted countercurrently with the descending heavy oil. Steam coils near the top of the tower, by imposing a temperature gradient, provide reflux so as to maximize the selectivity of the separation.

The deasphalted oil solution withdrawn overhead, which contains most of the propane, is heated under pressure to evaporate the solvent, the heat being obtained largely from exhaust steam. The last traces of propane are removed by direct contact with steam at low pressure in the deasphalted oil stripper.

The asphalt solution from the bottom of the deasphalting tower is heated in a furnace, following which propane vapors are separated in a pressure flash drum. The final stripping is accomplished at low pressure as with deasphalted oil.

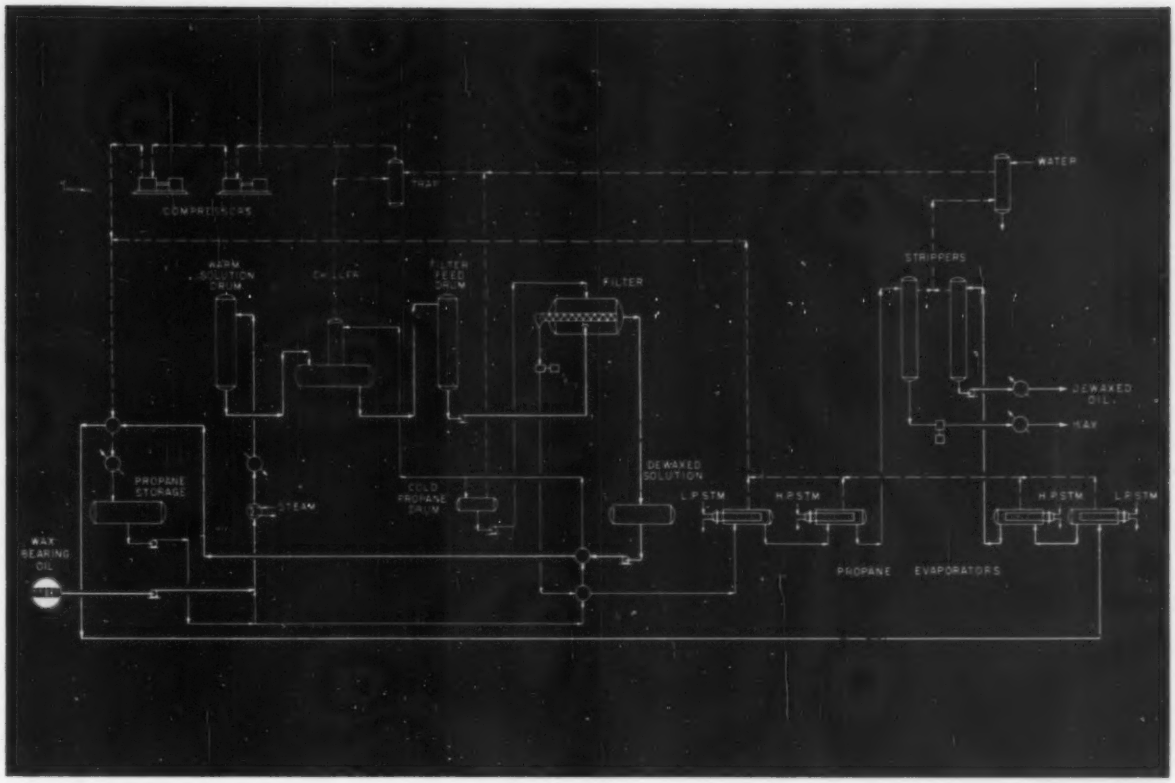
The flowsheet of a propane fractionation unit is similar to that shown above except that an additional extraction tower and an additional recovery system are added for each additional product.

Commercial Installations: There are about 30 Propane Deasphalting units in the U. S. and about 15 foreign installations. In addition there are three propane fractionation units producing two or more grades of lube stock and three which refractionate bottoms into two or more high-viscosity resins.

Yields: Typical yields for deasphalting and a comparison of distillation with propane fractionation follows:

	Oklahoma	Iraq	Le Duc	Illinois		Pennsylvania	West Edmond
Reduced Crude:							
Gravity—°API	19.3	7.1	12.1	13.7		25.1	19.3
SSU Vis. at 210 F	385	4888	2050	1760		220	514
Conradson Carbon, Weight Percent	7.3	19.7	17.1	13.4		2.76	5.9
Deasphalted Oil:							
Yield—Vol. Percent	75.6	34.1	47.1	44.3	50.7	83.7	39.4
Gravity—°API	23.6	20.2	22.7	24.2	23.4	26.6	24.7
SSU Vis. at 210 F	141	179	199	158	190	144	155
Color ASTM	6	8	6—	5—	5—	4½—	4½—
Conradson Carbon, Weight Percent	1.48	2.36	1.7	1.2	1.4	1.1	0.97
Asphalt:						Resins	
Yield—Vol. Percent	24.4	65.9	52.9	55.7	49.3	16.3	60.6
Specific Gravity °API	1.0227	1.0639	1.0542	1.023	1.030	0.9529	15.8
Softening Point °F	144	145	176	135	145	.....	.....
S.F. Viscosity at 210 °F	.....	.....	.....	.....	.....	339	.....
Solvent/Oil Ratio—Volume	7.8	9.9	7.9	8	8	12.7	6

	Medium Neut.	Cylinder Stock	Residue
Vacuum Distillation:			
Yield Percent on Crude	13.0	.....	14.3
Position in Crude—Percent	72.7-85.7	Not Produced	85.7-100
Viscosity SSU at 210 F	90.7	.....	6840
Gravity—°API	19.0	.....	7.3
Color—ASTM	5 (D)	.....	.....
Conradson Carbon—Weight Percent	2.1	.....	21.4
Dewaxed (0°F. Pour Pt.) V.I.	50.2	.....	.....
Propane Fractionation:			
Yield Percent on Crude	8.6	3.2	11.5
Position in Crude—Percent	76.7-85.3	85.3-88.5	88.5-100
Viscosity SSU at 210 F	94.0	239	.....
Gravity—°API	24.3	18.0	1.6
Color—ASTM	4½	5	.....
Conradson Carbon—Weight Percent	0.66	2.6	.....
Dewaxed (0°F. Pour Pt.) V.I.	80.6	.....	.....
Softening Pt. (R & B) °F	.....	.....	130



Propane Dewaxing and Deoiling—THE M. W. KELLOGG COMPANY

Application: Separates high pour point waxy materials from lubricating oils by crystallization and filtration. Propane Deoiling similarly processes oily waxes to specification oil content.

Charge: Waxy distillates and residuals ranging from diesel oil to highest viscosity grades of cylinder stock. Narrow-cut and very wide-cut fractions are dewaxed with equal success.

Product: Zero or lower pour test oils with exceptionally low cloud points and wax. With Propane Deoiling crystalline and microcrystalline waxes of any oil specification may be produced.

Description: Oil and propane are continuously charged through a heater which insures that all wax crystals are dissolved. The charge solution, after being held briefly in the warm solution tank, enters one of two parallel chillers in which its temperature is reduced at a controlled rate to filtering temperature by evaporation of propane. During chilling, wax crystals form and remain suspended in the propane-oil solution. The chilled slurry is charged to one or more continuous rotary filters via a filter feed tank. The wax cake on the filter is washed with cold propane to free it of oil, after which it is discharged to the wax recovery system. The filtrate, which comprises the wax-free oil together with most of the solvent and wash propane, is processed in a similar recovery system.

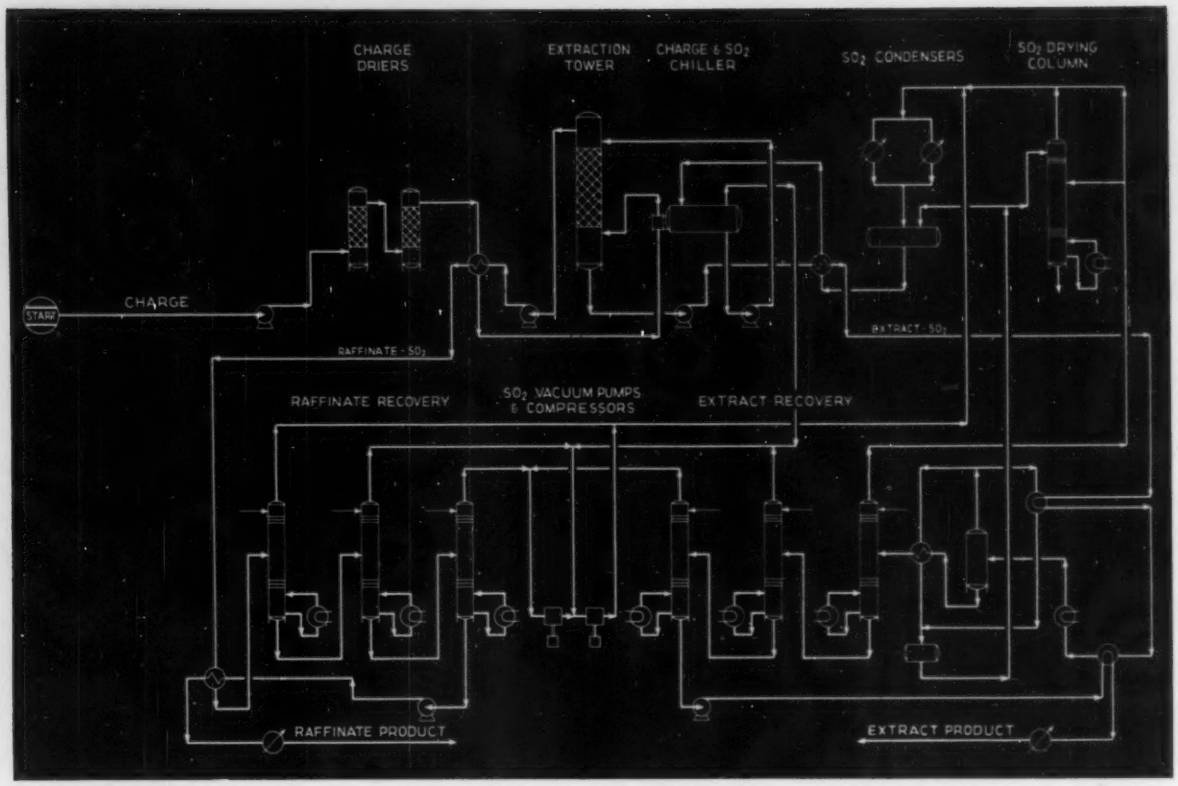
In brief, the product recovery systems comprise steam-heated evaporators operated under sufficient pressure that the vaporized propane can be condensed for re-use with plant cooling water, followed by direct steam strippers held at atmospheric pressure. Only the traces of propane removed in the strippers, plus that vaporized during the chilling operation, require compression.

The simplicity and economy of the process result largely from the fact that a single fluid—ordinary propane—serves as solvent, as diluent, as refrigerant and (in vapor form) as blanketing gas and filter blow-back. In dewaxing oils of varying viscosities, the only solvent adjustment required is the ratio of propane to oil. By merely lowering the pressure of the charge oil-solvent mixture, evaporation of solvent occurs with consequent refrigerating effect.

Yields: The following table gives the yields and inspections on four lubricating stocks:

	Propane Deasphalted Phenol Treated 15 Percent E. Texas Reduced Crude	Phenol Treated E. Texas Heavy Distillate	Propane Deasphalted Phenol Treated W. Edmond SAE 70 Stock	Propane Deasphalted Phenol Treated Okla. City SAE 40 Stock
Propane, Volume Percent	300	250	300	300
Filtering Temp., F	—34	—35	—40	—41
Dewaxed Oil Volume Percent	61.6	67.7	85.5	81.1
Inspections Waxy Oil:				
°API Gravity	29.7	32.0	27.4	30.1
SSU Viscosity at 210 F	93.1	57.3	132	72.7
Color ASTM	4½—	2—	3½—	2—
Carbon Residue, Percent	0.20	.....	0.25	0.06
V.G.C.	.795	.790	.803	.797
Dewaxed Oil:				
°API Gravity	27.6	28.9	26.7	28.7
SSU Viscosity at 210 F	118.4	66.2	150.0	79.6
Color ASTM	4½—	2—	3½—	2—
Pour Point, F	0	0	0	—5
Carbon Residue, Percent	0.26	0.03	0.30	0.05
Viscosity Index	95	92.1	91.1	92.1
V.G.C.	.804	.808	.807	.804

Commercial Installations: There are 8 domestic and 7 foreign units in operation.



SO_2 Extraction—STONE & WEBSTER ENGINEERING CORPORATION

Application: To remove aromatic hydrocarbons and sulfur bearing compounds from paraffinic and naphthenic hydrocarbons to produce high quality raffinate products. The process can also be used to recover high purity aromatics.

Charge: The fractions range in boiling point from naphtha and catalytic reformates through kerosine, gas oils, cycle oils from catalytic cracking and low and medium viscosity lubricating oils. Minor modifications in design permit blocked-in operation for a wide variety of charge stocks.

Product: The extraction of the aromatic hydrocarbons may serve two purposes; the quality of the remaining oil may be upgraded or the aromatic fraction may be the desired product.

Description: The accompanying diagram illustrates the flow in a plant designed for handling stocks ranging from light naphthas to light lube oil distillates.

The charge stock is pumped through a coalescer for the removal of free water and then through a dryer. The charge oil is next cooled by heat exchange with raffinate solution and further by refrigeration with SO_2. It is then introduced into the lower section of the packed extraction tower.

In the extraction tower, the charge oil is contacted with chilled liquid sulfur dioxide and is separated into a refined oil phase and an extract phase. The latter contains most of the SO_2 used for the extraction. The raffinate phase leaves the extraction tower at the top, while the extract phase accumulates in the base section. Both phases are pumped into their respective solvent recovery sections in which the SO_2 contained in the oil is removed in a series of evaporators.

The process consumes liquid sulfur dioxide at the rate of about 0.15-pound per barrel of charge. This loss is due to leakage, venting of the condensers, and incomplete recovery from the products and from the water removed in the drying tower.

Operating Conditions: Extraction temperatures of —20 F. to +60 F. are used, the lower temperatures for platformate and kerosines and the higher temperatures for high pour point stocks. The high selectivity of SO_2 permits the use of a very low SO_2 treat, 0.62 to 1.65 per vol. of charge, coupled with a low number of extraction stages, usually 2-5.

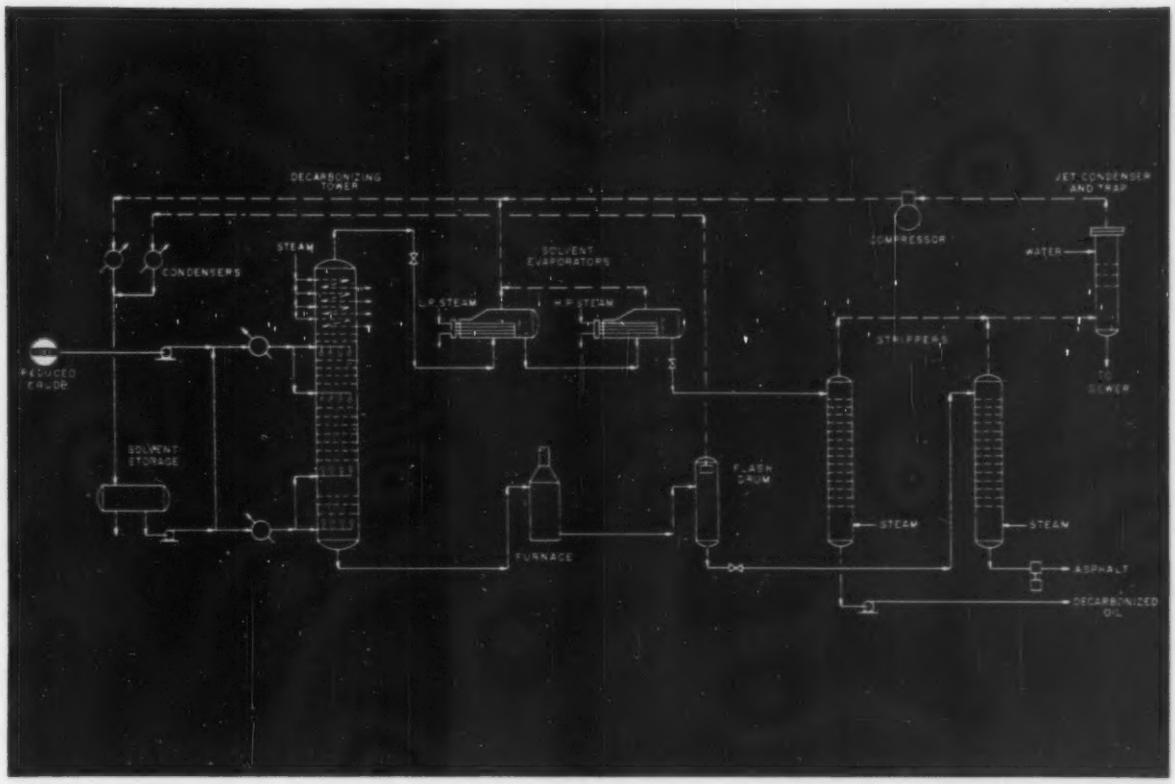
Yields: High purity benzene, toluene and xylenes are extracted from platformates with simultaneous individual aromatic recoveries greater than 97 percent.

Lamp oils are improved to a smoke point of 30-40 with removal of 75-90 percent of the original sulfur and 85-95 percent of the original aromatics present in the feed. Raffinate yields vary from 75-90 percent by volume referred to paraffins in feed.

Treatment of gas oils produces raffinates containing 5 percent or less of aromatics and extracts of an aromaticity of 70-80 percent. The process produces premium quality diesel fuels from straight run or cracked stocks. The treatment of catalytic cracking cycle stock reduces the coke laydown in subsequent cracking by 50 percent or more.

Commercial Installations: The total installed charge capacity of SO_2 extraction plants in the U. S. and foreign countries is about 200,000 bpd. Plants for a total charge capacity of 114,000 bpd have been built by Stone & Webster Engineering Corporation and its affiliates.

Reference: PETROLEUM REFINER, vol 30, no 9, p 237 (Sept, 1951).



Solvent Decarbonizing—THE M. W. KELLOGG COMPANY

Application: To recover paraffinic catalytic cracking stock from distillation residues, increasing yields of light products at the expense of fuel oil.

Charge: Atmospheric or Vacuum reduced crude.

Product: A premium catalytic cracking feedstock and a virgin asphalt which, if from suitable crude, may be blended to paving specifications.

Description: Solvent decarbonizing is a low-temperature extraction process. The feed is reduced in temperature by heat exchange and cooling and charged to the decarbonizing tower. Solvent, introduced near the bottom of the tower, is contacted counter-currently with the descending heavy oil. Steam coils near the top of the tower, by imposing a temperature gradient, provide reflux so as to maximize the selectivity of the separation.

The decarbonized oil solution withdrawn overhead is heated under pressure to evaporate solvent, most of the heat being obtained from exhaust steam. The last traces are removed by direct contact with steam at low pressure in the decarbonized oil stripper.

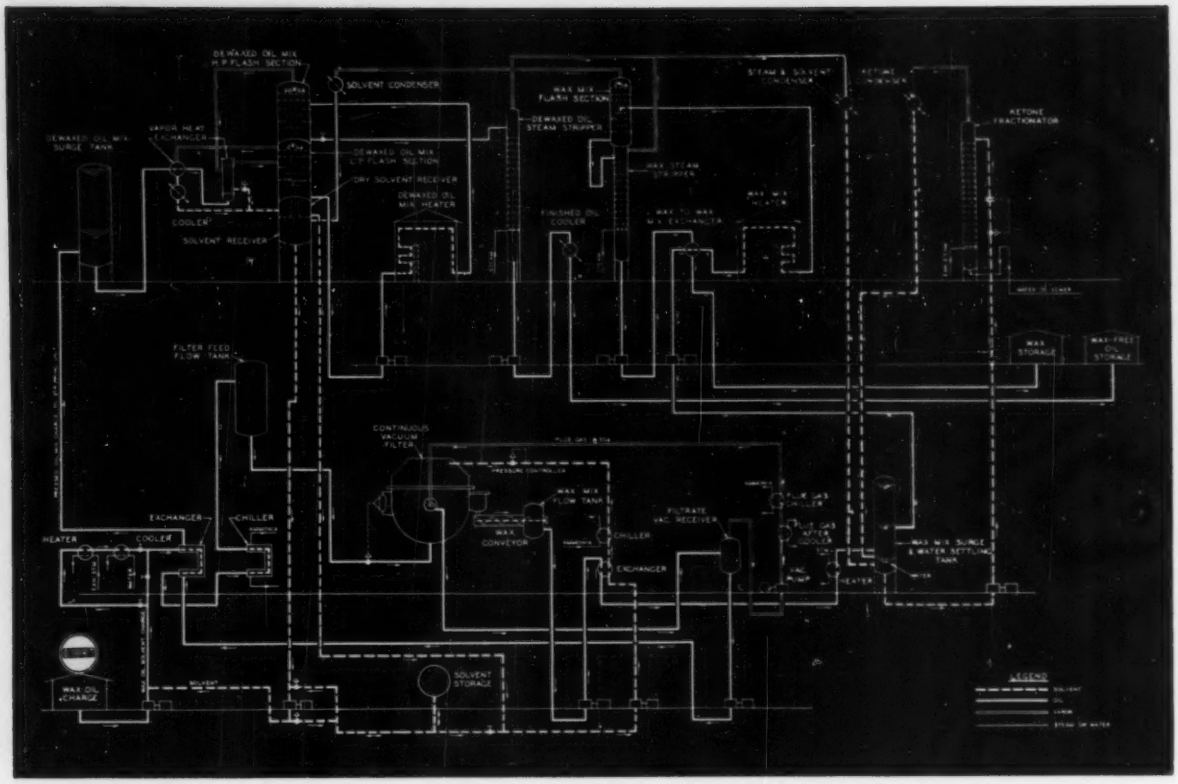
The asphalt solution from the bottom of the decarbonizing tower is heated in a furnace, following which solvent vapors are separated in a pressure flash drum. The final stripping is accomplished at low pressure as with decarbonized oil.

Operating conditions: Normally, the top temperature ranges between 160 and 220 F. and the pressure from 450 to 600 psi. The solvent ratio and temperature gradient are determined by the selectivity requirements. Solvent composition is adjusted to provide the necessary solubility.

Yields: Typical yields and product properties shown below are illustrative only.

	A	B	C	D	E	F	G
Reduced Crude:							
Volume Percent Crude	11.1	19.8	22.2	32.3	29.2	20.0	16.0
Gravity, °API	11.3	13.0	5.3	10.1	12.0	6.3	9.6
Conradson Carbon Weight Percent	15.0	13.3	21.5	16.0	12.1	22.2	18.9
SSU at 210 F	2,193	812	.....	.....	526	.....	.....
SFs at 210 F	.....	.....	772	162	.....	990	179
SiO_2-free ash, ppm	489	149	350	237	936	848	265
Metals, ppm:							
Vanadium	23.1	27.6	84.1	61.6	27.6	136.0	30.0
Nickel	14.2	11.9	27.6	19.9	16.0	139.0	46.6
Iron	18.2	56.6	13.2	6.7	13.2	93.0	39.3
Copper	.....	.....	3.7	0.8	1.6	0.94	1.4
Decarbonized Oil:							
Volume Percent Charge	62.9	69.0	35.0	47.0	66.0	52.8	67.8
Gravity, °API	19.0	20.5	19.3	20.3	19.6	18.3	17.8
Conradson Carbon, Weight Percent	4.2	2.6	4.3	2.6	2.2	5.3	5.4
SSU at 210 F	294	163	193	.....	113	251	250
SiO_2-Free Ash, ppm	9.2	8.9	8.8	7.6	6.2	25.5	10.7
Metals, ppm:							
Vanadium	1.23	0.36	1.88	0.73	1.34	2.3	1.4
Nickel	1.10	0.56	0.92	0.38	0.99	8.1	3.9
Iron	0.49	0.90	0.96	1.70	0.66	3.5	Trace
Copper	.....	.....	0.03	0.04	0.15	0.03	0.02
Asphalt:							
Volume Percent Charge	37.1	31.0	65.0	53.0	34.0	47.2	32.2
Specific Gravity	1.076	1.086	1.087	1.059	1.083	1.119	1.120
R & B Soft. pt., °F	188	196	142	132	171	246	224
Percent of Metals in reduced Crude rejected to asphalt Fraction	97.1	98.8	99.1	98.6	96.6	98.2	97.1

Commercial installations: At present, five Propane Decarbonizing units with a total capacity of 70,000 barrels per day are in operation. Others are being engineered or planned.



Solvent Dewaxing—TEXACO DEVELOPMENT COMPANY

Application: For the removal of wax from lubricating oil stocks.

Charge: Either distillate or residual stocks of practically any viscosity in the raw or refined state from any crude source can be dewaxed.

Product: Dewaxed oils with pour points equal to or within a few degrees of the dewaxing temperature.

Description: The accompanying flow diagram shows the flow through the unit. In operation, the dilution solvent is introduced into the wax-bearing oil stream in such amounts at selected points in the chilling cycle as to insure a wax crystal structure and liquid viscosity most suitable for filtration.

The chilled charge mixture flows from the double pipe chillers through a filter feed tank to drum-type vacuum filters in which compartmentized, cloth covered drums rotate, half submerged in enclosed filter cases. A wax-free oil filtrate solution is drawn through the filter cloth to filtrate tanks in which the vacuum, which induces filtration, is maintained. The wax cake deposited upon the drum during filtration is washed with cold solvent as it emerges from the liquid level in the filter. Just before each of the filter drum compartments reaches the wax deflector, flue gas at low pressure is admitted through a blow-back connection to the underneath side of the filter cloth. The bond between wax and cloth is broken and the washed wax falls into the wax discharge compartment. Controllers in the flue gas piping maintain an atmosphere pressure in the filter hood.

The filtrate from the filtrate receiver is pumped through the double pipe exchangers to evaporators for recovery of the solvent. Heat for evaporating the solvent from the dewaxed oil solution and the wax mix may be supplied by either steam or fire heaters.

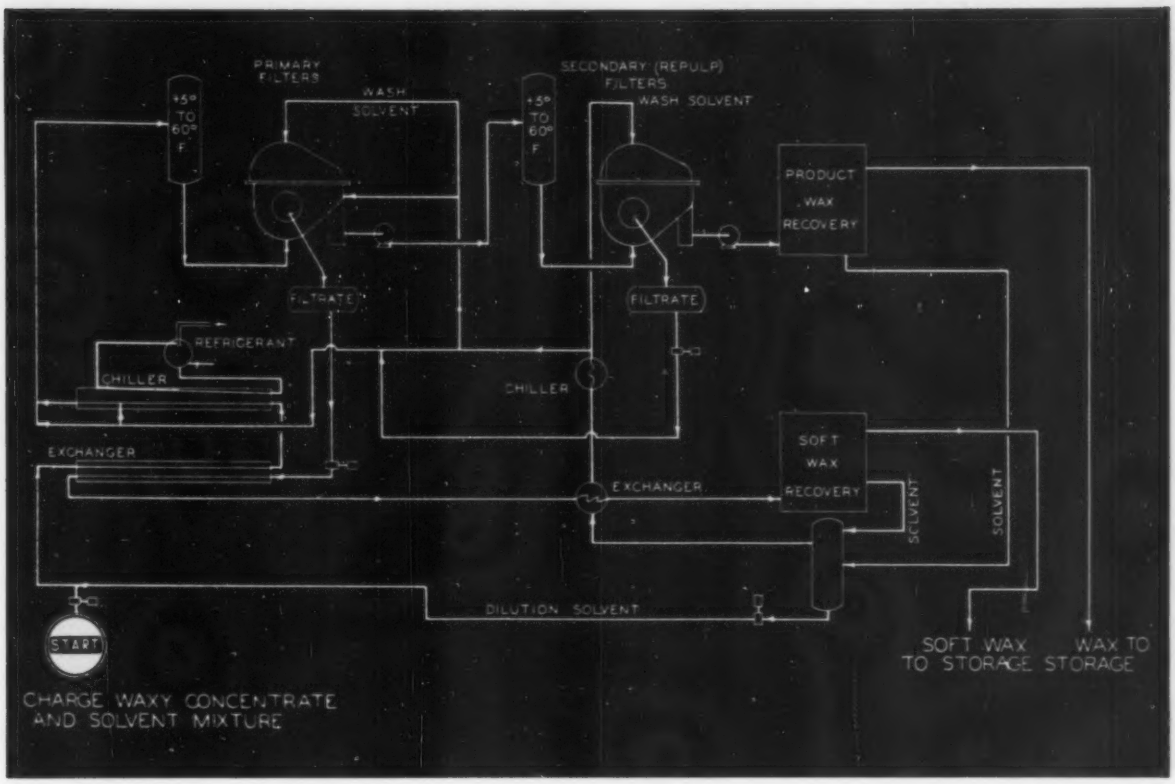
The solvent employed generally consists of a mixture of methyl ethyl ketone and an aromatic solvent (benzol, toluol or a mixture of the two). Because of its relatively low boiling point, the solvent can readily be recovered from the dewaxed oil and wax solutions in simple evaporating equipment for continuous re-use.

Operating Conditions: Dilution solvent dosages vary from a solvent-to-oil ratio of 1.0:1 to as much as 4.0:1 depending on the nature and viscosity of the charge stock. The temperature for dewaxing is dependent upon the desired pour point of the dewaxed oil and is equal to or only a few degrees below the pour point. Low pressures exist throughout the process.

Yields: The yields of dewaxed oil are dependent upon the wax content of the charge stock. Practically complete separation of oil from wax is obtained by the use of the cold displacement wash applied on the filter.

Commercial Installations: Seventy-four units have been installed. One additional unit is under contract for construction.

Reference: PETROLEUM REFINER, vol 15, no 6, p 205 (June 1936).



Wax Fractionation—TEXACO DEVELOPMENT CORPORATION

Application: For the production of wax of low oil content.

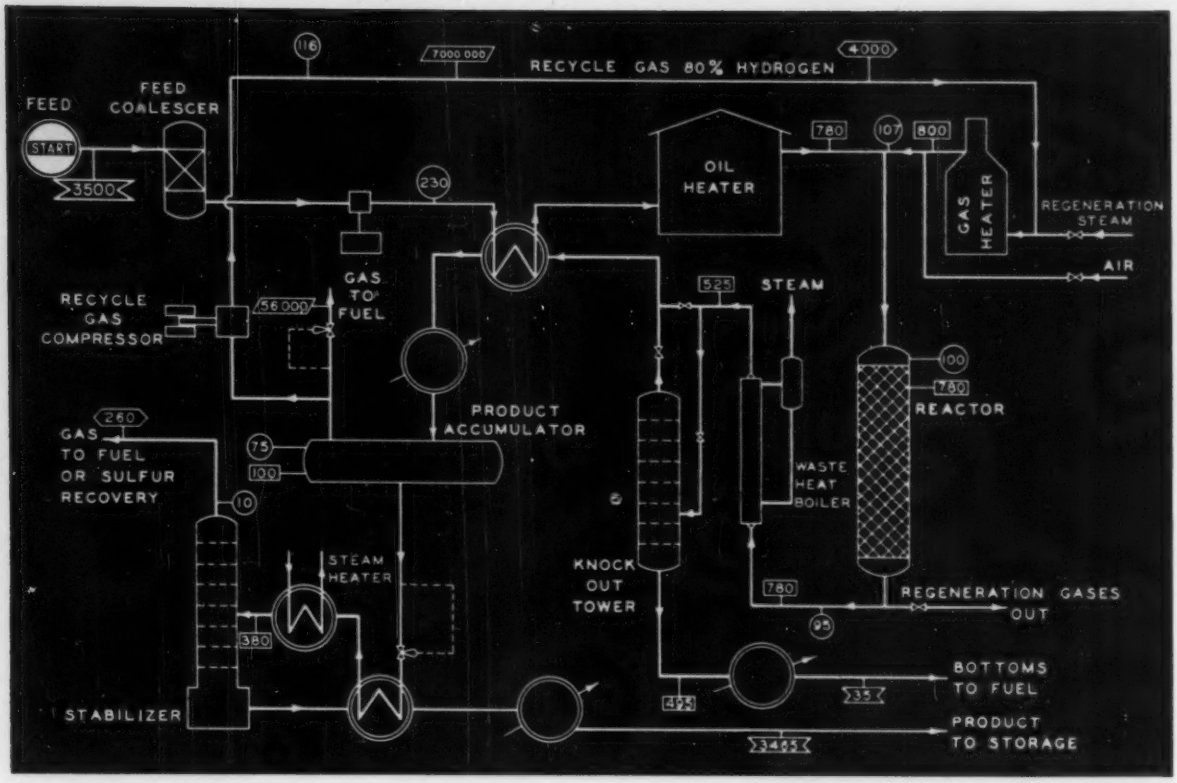
Product: Crystalline and micro-crystalline waxes with melting points depending upon the nature of the charge stock can be produced by this process. Crystalline waxes which consistently show oil contents by ASTM analysis that are below 0.5 percent can be produced. Depending upon the source of the raw waxy concentrate, finished micro-crystalline waxes can be produced which, without additives of any kind, have melting points as high as 200 F. and asphalt penetrations at 77 F. as low as one.

Descriptions: The process employs an operating technique involving the crystallization of wax or a selected portion of the wax contained in a waxy concentrate in the presence of a substantial amount of solvent, added to the charge stock before any of the wax is crystallized. The solid wax is separated from the liquid phase by filtration at a temperature suitable for the desired degree of fractionation.

Typical of the combined operation of the Solvent Dewaxing and Wax Fractionation process is a case in which low pour point dewaxed oil and wax of low oil content are produced concurrently. In the operation, a mixture of the wax-bearing charge stock with a substantial amount of solvent is chilled in double pipe scraped surface chilling equipment to a temperature suitable for the production of dewaxed oil of the desired pour point. The mixture is then filtered and the oil-bearing solution in the wax cake is washed continuously from the wax by displacement with cold solvent. The wax cake is continuously discharged from the primary filters and heated until the wax is totally dissolved in the solvent. Additional warm solvent is blended with the wax cake solution and the mixture cooled in double pipe scraped surface equipment to a predetermined temperature necessary to crystallize the desired wax fractions and obtain the proper quality of wax. The recrystallized wax is then continuously separated by means of a second filter on which the wax receives a final wash. The wax cake from this filter is pumped to the solvent recovery system from which the solvent-free product wax of low oil content is recovered. The filtrate from the secondary filter containing a small amount of oil and undesirable soluble wax fractions is pumped to the solvent recovery system from which the "soft" wax is delivered to storage tanks.

Over-all solvent dosages for a combined dewaxing and wax fractionation operation vary from a solvent-to-oil ratio of approximately 3.5:1 for low viscosity lubricating oil distillate stocks to 9.0:1 or more for viscous residual stocks.

Commercial Installations: Thirty-one commercial installations employ the Wax Fractionation process in the production of high quality waxes. Two additional units are under construction.



Autofining—THE BRITISH PETROLEUM COMPANY, LTD.

Application: Desulfurizes distillate feeds without requiring an external source of hydrogen.

Charge: Straight-run distillates up to 700 F. end point also aromatic extracts and blends with cracked distillates.

Product: With almost complete desulfurization the light products show an increase of 2-4 octane numbers (clear) and a greatly increased lead response.

Description: The accompanying flow diagram is an Autofining unit designed to handle solvent naphthas and power kerosines. The feedstock and the recycle gases are vaporized and heated in separate heaters and pass downward through the reactor. The hot vapors from the reactor pass through a waste heat boiler; after heat exchange and cooling, the products flow to the separator from which the recycle compressor takes suction. If it is desired to meet a color specification with products such as power kerosines, the products leaving the waste heat boiler pass into the knock out tower where 1 to 2 percent volume of heavy ends are removed. Any excess gas make is passed to fuel from the product separator. Liquid product from the separator passes to a flash tower stabilizer to remove the hydrogen sulfide and to meet flash point specifications. The stabilizer product is normally free of hydrogen sulfide but a light caustic soda wash may be advisable to guard against poor stabilizer operation.

Granular (2 to 4 mesh) or pelleted catalyst is used and a life of over six years has been obtained. Regeneration of the catalyst can be readily accomplished by air/steam or inert gas/air mixtures when the full activity of the catalyst can be restored.

Operating Conditions: The usual operating temperature range 750-800 F. Pressures may be held at 100-200 psig by venting excess recycle gas, or allowed to reach equilibrium in the system when the pressure may rise to 600 psig.

Commercial Installations: The initial plant built in 1948 at the BP Grangemouth Refinery, Scotland, has been increased to a 500-barrel-a-day unit, and 3,500-barrel-a-day units are also in operation in BP's refineries at Llandarcy, Wales, and at Aden.

Reference: PETROLEUM REFINER, vol32,no12,p84(Dec,1953).

Yields: Typical yields and properties when operating on Middle East feedstock are shown in the following table.

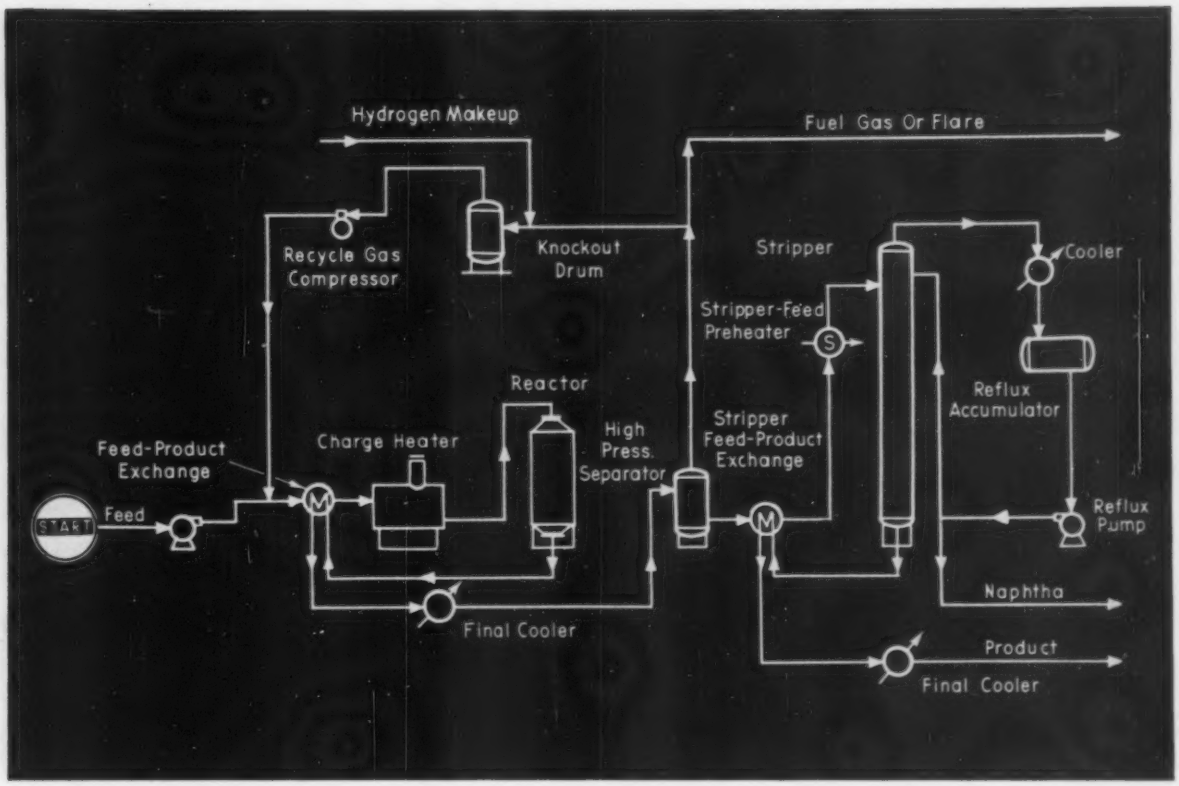
Method of Operation	Power Kerosine* Constant Pressure (100 psig.)		Straight-Run Gas Oil Equilibrium Pressure (500 psig.)	
Yield:				
(Weight Percent on Feed)	99.0		96.0†	
Sulfur Removal Percent	70.0		92.0	
	Feed	**Product**	**Feed**	**Product**
°API at 60 F	39.6	40.2	36.3	38.0
I.B.P., F	284	291	482	360
E.P., F	502	500	684	671
Sulfur, Wt. Percent	0.8	0.24	1.25	0.1
F-2 Octane, Clear	52	53	.....	.....
Diesel Index	.....	.....	60	60

† 1.4 percent weight light ends not included. * Including 10 percent Cat. cracked component.

Economics: Installation costs are $120 to $300 per barrel for capacities from 2,000 to 20,000 bpsd.

Typical operating costs for 10,000 bpsd units are given below.

FEEDSTOCK	Kerosine	Gas Oil
Operating cost, ¢/bbl input:		
Fuel @ 1 $/bbl	2.0	1.8
Power @ 0.8 ¢/kwh	0.8	2.7
Water @ 1 ¢/1,000 US Gal	0.3	0.3
Steam @ 30 ¢/1,000 lb	—1.0	—0.4
Catalyst @ $1.25/lb	0.6	2.5
Labor @ $60/day and supervision @ 15%	2.1	2.8
Total direct operating cost	4.8	9.7
Maintenance @ 4% plant investment	1.9	2.2
Property taxes and insurance @ 2% plant	0.9	1.1
Interest @ 4% and depreciation @ 10% plant	6.6	7.9
Total operating cost ¢/bbl. input	14.2	20.9



Diesulforming—HUSKY OIL COMPANY

Application: Diesulforming is a hydrogen treating process that reduces sulfur content of the feed stock. The process also removes nitrogen and oxygen and provides color, odor and cetane improvement.

Charge: The feed stocks which can be processed vary from gasolines to vacuum distillates. Either cracked or straight run are adaptable. Table I gives typical inspection data of both the feed and product materials.

Description: The Diesulformer must be closely integrated with a source of necessary hydrogen. The distillate feed stock and hydrogen recycle are preheated by exchange with the reactor effluent before being brought to the reaction temperature in heater. Feed and recycle mixture passes down through the fixed catalyst reactor. After passing through the charge heat exchanger, the reactor effluent is water cooled and goes to the separator where the liquid product is separated from the recycle gas stream which is recirculated by a compressor. Make-up hydrogen is introduced in the suction side of this compressor.

Liquid from the flash drum is stripped of hydrogen sulfide and low flash constituents. The bottom product from stripper is sweet desulfurized distillate. The small volume of H_2S-saturated naphtha recovered from the stripper overhead can be treated like any other sour gasoline.

Materials of construction must be adequate to resist hydrogen and hydrogen sulfide. Concentrations of chromium and molybdenum are effective to prevent hydrogen damage, but certain parts require high chromium steels to withstand hydrogen sulfide.

The catalyst can be regenerated in place by burning off contaminants. Under normal operating conditions, the catalyst is expected to last indefinitely.

Desulfurization is directly proportional to the temperature and inversely proportional to the space velocity. Secondary variables pressure, purity of hydrogen, and recycle rate are interrelated.

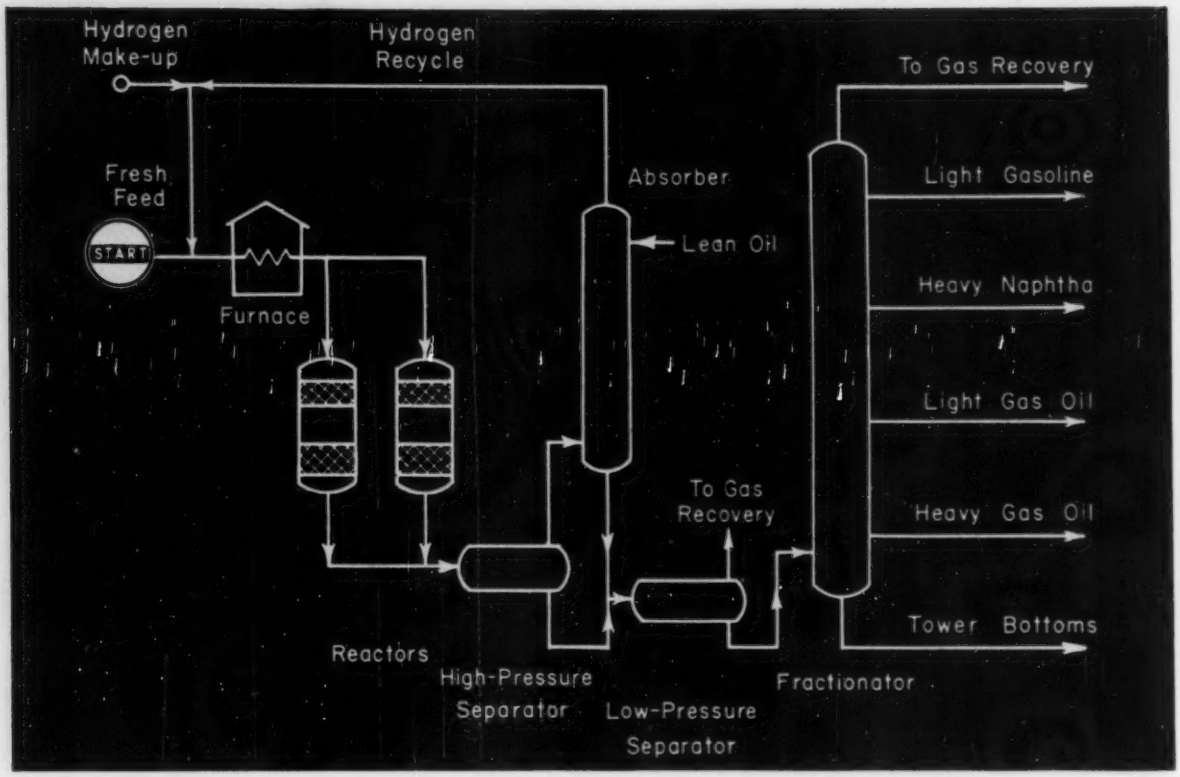
Yields and Operating Conditions:

Space Velocity, W/Hr/W	1-2
Gas Recycle, SCF/Bbl. of Charge	5000
Pressure, psig	300-500
Temperature, °F	600-800

	MED. DIST.		LIGHT DIST.	
	Charge	Product	Charge	Product
Liquid Yield, Vol. %	100	100.1	100	100.2
H_2 Consumption, SCF/Bbl.	....	150	....	92
Total Sulfur, Wt. %	2.2	0.35	1.02	0.1
Gravity, °API	30.2	33.2	39.2	40.6
Distillation:				
I.B.P.	473	415	379	363
10%	516	512	408	393
50%	570	564	440	432
90%	624	617	495	488
E.P.	656	658	533	545
Flash, °F	230	152	154	147
Aniline Point, °F	142	152	136	143
Pour, °F	5	5	—50	—50
Doctor Test	....	.....	DNP	Pass
Odor	Poor	Good	Poor	Good
Cetane No.	48	58	45	47

Commercial Installation: The first commercial installation was made in the U. S. in 1953 at the Husky Oil Company refinery in Cody, Wyoming.

Reference: PETROLEUM REFINER, vol 34, no 9, p 158 (Sept, 1955).



Gulf HDS—GULF RESEARCH AND DEVELOPMENT COMPANY

Application: Upgrades the quality of high sulfur sour crudes and residual stocks by hydrogenation at moderate pressure.

Charge: High sulfur crude oils and residual stocks.

Product: Low sulfur stocks.

Description: Fresh feed to the unit, together with hydrogen make-up recycle gas is heated to the desired reaction temperature in a furnace and the combined streams enter the reactor which is "on stream." The reactor effluent, after being cooled in exchangers, enters the high-pressure flash drum where the rich gas is flashed off as feed to the absorber tower. Condensate from the high-pressure drum goes to the low-pressure drum where it is combined with the rich oil from the absorber tower. Condensate from the low-pressure drum is fed to the fractionator tower for separation of the desired products. During the processing periods part of the sulfur and some coke are deposited so that periodic regeneration is required. Much of the sulfur, which was converted to H_2S during the reaction period, goes along with the lighter gas and is eventually stripped out in the recovery system.

Regeneration of the catalyst is accomplished by preheating either a live steam- or flue gas-air mixture to a temperature of about 750 F. in a radiant furnace and then passing it through the reactor to be regenerated. The rate of regeneration is controlled by keeping a constant reactor inlet temperature and air-to-steam ratio.

Operating Conditions: Normal range of operating conditions vary with the feed stock and the degree of desulfurization desired, as given below.

Reactor Temperature	F	750-850
Reactor Pressure	PSIG	500-1000
H_2 in Recycle Gas	Vol. %	65-90
Space Velocity	V/Hr/V	0.5-2.0
Recycle Gas Rate	SCF/bbl.	2500-5000

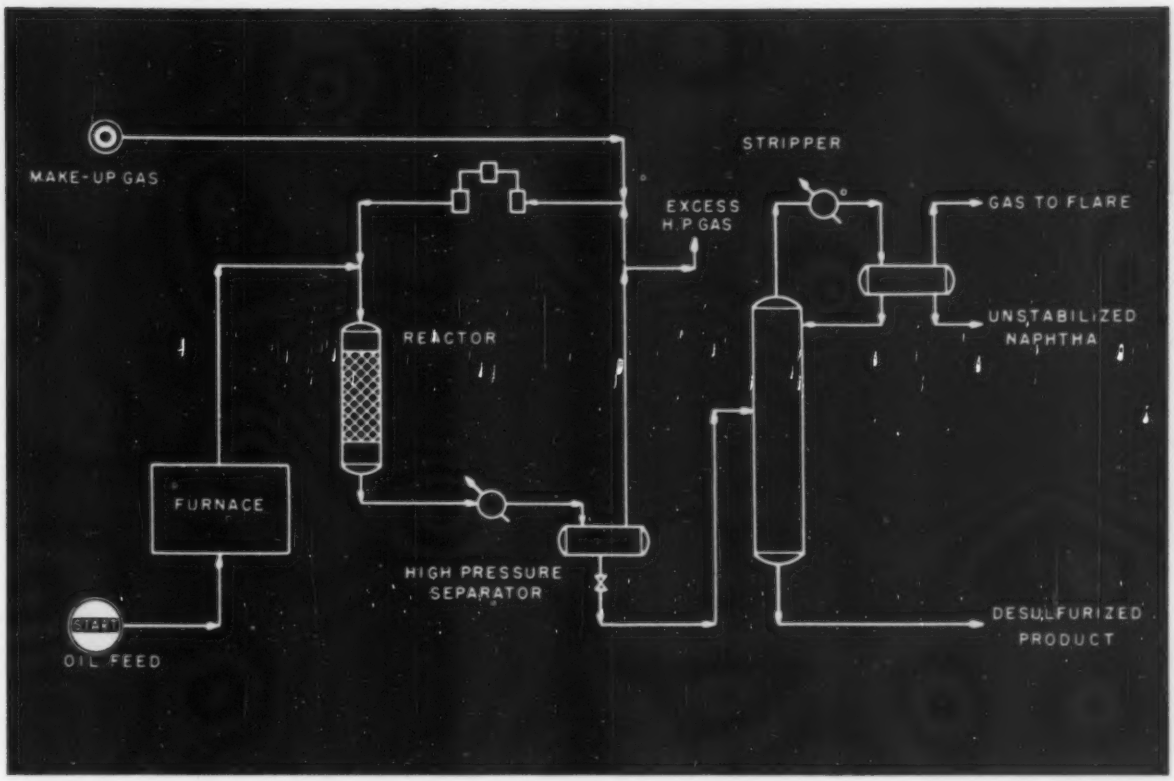
Yields: See the following table. Data on individual fractions given in the reference cited.

	Kuwait Whole Crude		Kuwait 17% Reduced Crude	
	Charge	Product	Charge	Product
Total Charge & Product:				
Yield, Volume Percent	....	96.0	....	101.8
Desulfurization, Percent	....	82.5	....	69.9
Gravity, °API	30.8	42.4	5.8	20.8
Sulfur, Percent	2.61	0.46	5.45	1.64
Carbon Residue, Percent	5.3	0.06	19.8	8.43

Economics: It is estimated a 20,000-bpcd fixed bed unit on the Gulf Coast processing a whole West Texas crude would require an investment of approximately $500 per barrel of daily capacity, a direct operating cost of 25 cents per barrel, and a total operating cost (including 10% depreciation and all fixed charges) of 50 cents per barrel. Correspondingly, the same size unit processing a 71/29% blend of Kuwait vacuum-tower bottoms and light catalytic cycle oil at an East Coast location would require an investment of approximately $800 per barrel of daily capacity, and have a direct operating cost of 75 cents per barrel, and a total operating cost of $1.10 per barrel. These investment and operating costs include complete facilities for the manufacture of hydrogen. Chemical and utility requirements are given in the literature cited.

Commercial Installations: There are no commercial units to date. The M. W. Kellogg Company is the licensing agent.

Reference: PETROLEUM REFINER, vol 34, no 5, p 156 (May, 1955).



Hydrodesulfurization—THE M. W. KELLOGG COMPANY

Application: For the removal of sulfur, nitrogen, oxygen and metal compounds from raw naphthas and distillates. For cracked or degraded stocks it simultaneously eliminates unsaturated constituents, restoring color and stability qualities.

Charge: Virgin and cracked naphthas, kerosine, diesel and furnace oils.

Product: Purified and saturated feed naphthas for catalytic reforming, low-color, stable, desulfurized kerosine, diesel and furnace oils and improved catalytic cracking feed and recycle stocks.

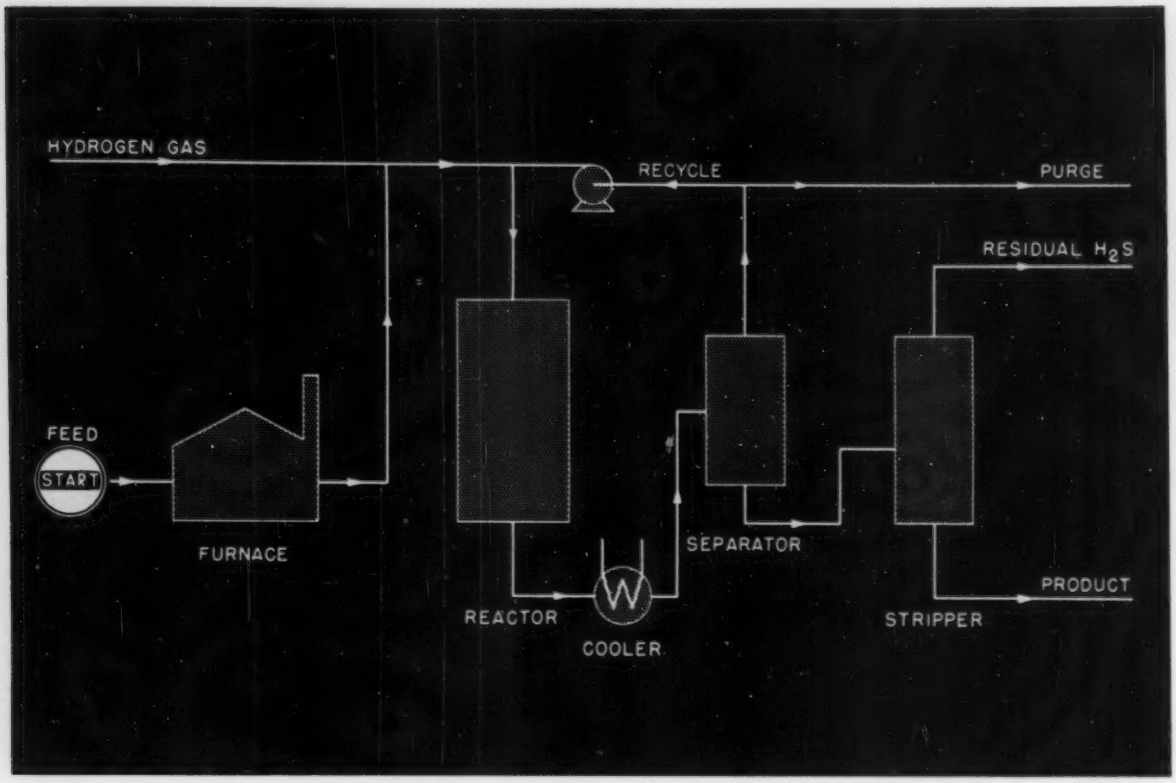
Description: Kellogg Hydrogen Desulfurizing is a mild catalytic hydrogenation process. The incoming feedstock receives preheat against the product stripper bottoms and the total reactor effluent before entering the furnace where it is heated to slightly above reaction temperature. The hydrogen-rich feed gas is compressed to the suction pressure of the recycle gas compressor and combined with the recycle gas stream. After further compression in the recycle machine the gas is heated by the reactor effluent and then mixed with the feed oil at the reactor inlet. The feed oil is sufficiently overheated to raise the recycle-feed gas to reaction temperature, and to provide the heat of vaporization of the oil itself. The reactants flow downward through the catalyst bed where the desired reactions are accomplished. The effluent, after providing stripper reboiler heat and pre-heat to incoming streams, is flashed in the high pressure separator. The flash vapor is utilized as recycle gas while the liquid is fed to the product stripper. The stripper overhead consists of dissolved gases and light ends; the bottoms is the stabilized product which may be subjected to further processing or sent directly to finished product storage.

Yields: The accompanying table illustrates typical product data for a unit operating on sour middle distillates:

Operating Conditions: Operating conditions vary widely depending upon the type of feedstock and the degree of improvement desired. Reactor temperatures range from 650 to 800 F. and pressures from 350 to 1,000 psia.

Commercial Installations: Kellogg desulfurization units, operating and under construction, running feedstocks ranging from kerosine to heavy gas oils account for a combined capacity of over 160,000 bpsd. Naphtha desulfurization units used primarily as catalytic reformer pretreaters, operating and contracted for, amount to an additional 157,000 bpsd, bringing the total capacity to 317,000 bpsd.

	Straight Run Gas Oil		Light Catalytic Cycle Stock	
	Feed	Prod.	Feed	Prod.
Gravity, °API	39.3	40.0	26.6	28.0
ASTM Distillation, °F				
I.B.P.	340	370	420	430
E.P.	600	600	650	650
Sulfur, Weight Percent	0.70	0.05	0.80	0.10
Weight Percent Desulfurization	....	93.0	....	87.5
Fuel Oil, Vol. Percent on Feed	....	96.8	....	98.0
Unstabilized Gasoline, Vol. Percent on Feed	.....	3.7	.....	3.0



Hydrofining—ESSO RESEARCH AND ENGINEERING COMPANY

Application: Improves the quality of a wide range of petroleum stocks by hydrogen treating. This versatile process may be used to remove sulfur and other impurities or to improve the odor, color, stability and other properties of a variety of products.

Charge: Virgin naphtha, cracked naphtha, solvents, jet fuel, kerosine, diesel fuel, heating oil, lubricating oils and waxes.

Product: Essentially 100 percent of the oil fed to an Esso Hydrofiner is recovered as finished product. Properties of the product will vary with the severity of treatment used in this flexible process. When treating naphthas, Hydrofining will reduce sulfur content and odor and prevent formation of gummy deposits which tend to foul engines. Hydrofining reduces sulfur and improves the odor, color, and burning qualities of kerosine. High quality diesel fuels can be made from sour crudes. Applied to cracked heating oils, Hydrofining reduces carbon deposition and makes these stocks compatible with virgin heating oils. Catalytic cracking feed stocks, which have been Hydrofined, yield more naphtha and heating oil and less gas and carbon than do untreated stocks. Hydrofining improves color, odor, stability, demulsibility, and other properties of lubricating oils. It improves the odor, color and stability of refined waxes. Coal-tar aromatic streams with extremely low sulfur contents have been produced by this process.

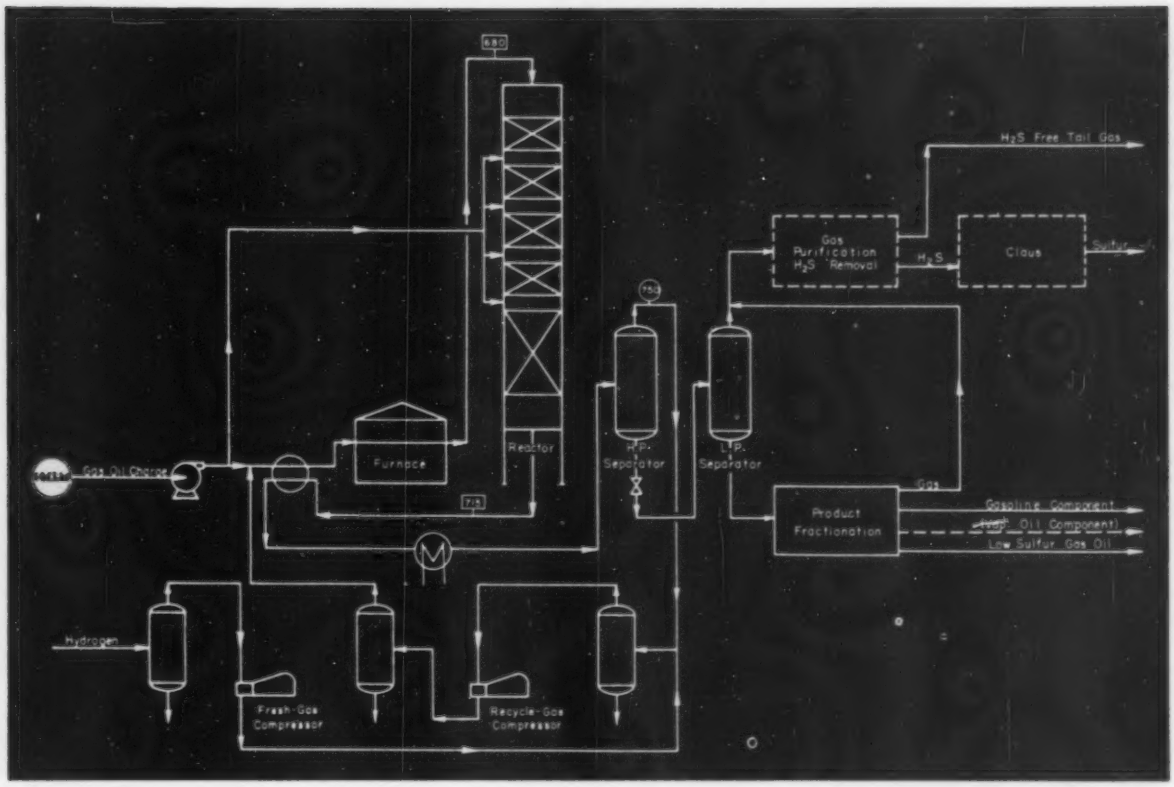
Description: The oil feed enters a coil furnace, where it is heated to a temperature usually between 550 and 800 F. It then passes to a fixed bed reactor vessel together with fresh hydrogen gas. In the reactor, the feed is treated in the presence of the hydrogen and a regenerable metal oxide catalyst at pressures usually between 50 to 800 psi. After leaving the reactor, the product is cooled before entering a separator from which hydrogen-rich gas may be recirculated back to the reactor in amounts varying according to the specific requirements of the finishing operation. After separation, the product stream enters a stripper where any residual hydrogen sulfide gas is removed.

Commercial Installations: The accompanying table summarizes Hydrofining plants built or being built by Esso affiliates and licensees. Slightly more than one-third of the total capacity shown is in the U. S. with the remainder distributed throughout Canada, Europe, Asia, Africa and South America.

Reference: PETROLEUM REFINER, vol 36, no 6, p 179 (June, 1957).

HYDROFINING UNITS
(Built, Building or Planned)

Principal Feed Stock	No. of Units	Capacity, BPSD
Catalytic Reformer Feeds	26	254,430
Other Naphthas	5	66,640
Solvents	6	18,270
Coal Tar Aromatics	1	1,300
Jet Fuel, Kerosine, Diesel Fuels, etc.	26	244,730
Heavy Gas Oils	2	53,800
Lubricating Oils	6	29,700
Wax	3	4,100
Total	75	672,970



Trickle Hydrodesulfurization—SHELL DEVELOPMENT COMPANY

Application: To remove sulfur from middle distillates by means of the reaction of sulfur compounds with a minimum amount of hydrogen.

Charge: Middle distillates such as straight-run and catalytically-cracked gas oils.

Product: A sulfur removal of 85 to 90 percent is obtained, a small fraction of high-octane gasoline being produced from the sulfur compounds.

Description: As shown in the diagram, the oil charge and fresh hydrogen, as well as recycle hydrogen, are combined. The combination is first preheated by exchange with hot reaction products, and then is heated in a small gas- or oil-fired furnace.

The reactor may contain a number of catalyst beds between which cold charge oil is injected to take up the heat produced in the exothermic hydrogenation reactions. The number of beds required depends upon the sulfur and olefin content of the charge stock and upon the degree of sulfur removal desired. With low-sulfur stocks, i.e., stocks with a sulfur content of, say, approximately 1 percent by weight or less, intermediate cooling may be omitted. The reaction products, after heat exchange with the feed, are cooled further and then passed to the high-pressure separator—from which, after the addition of makeup hydrogen, the gas is recycled. The liquid from the high-pressure separator is flashed in a low-pressure separator, and is then passed to a product fractionating section for removal of the remaining hydrogen sulfide and light ends.

If desired, an engine-fuel type of kerosine component may be recovered. The low-pressure tail gas may be passed to a gas-purification plant for removal of hydrogen sulfide, which may subsequently be converted to sulfur in a Claus plant.

For most commercial applications, the catalyst remains active over long periods. Regeneration, normally carried out at intervals of about one year, brings the catalyst back to initial activity.

Operating Conditions: The preferred operating conditions for deep sulfurization of middle distillates (80 to 90 percent sulfur removal) are 600 to 850 psia and 680 to 730 F.

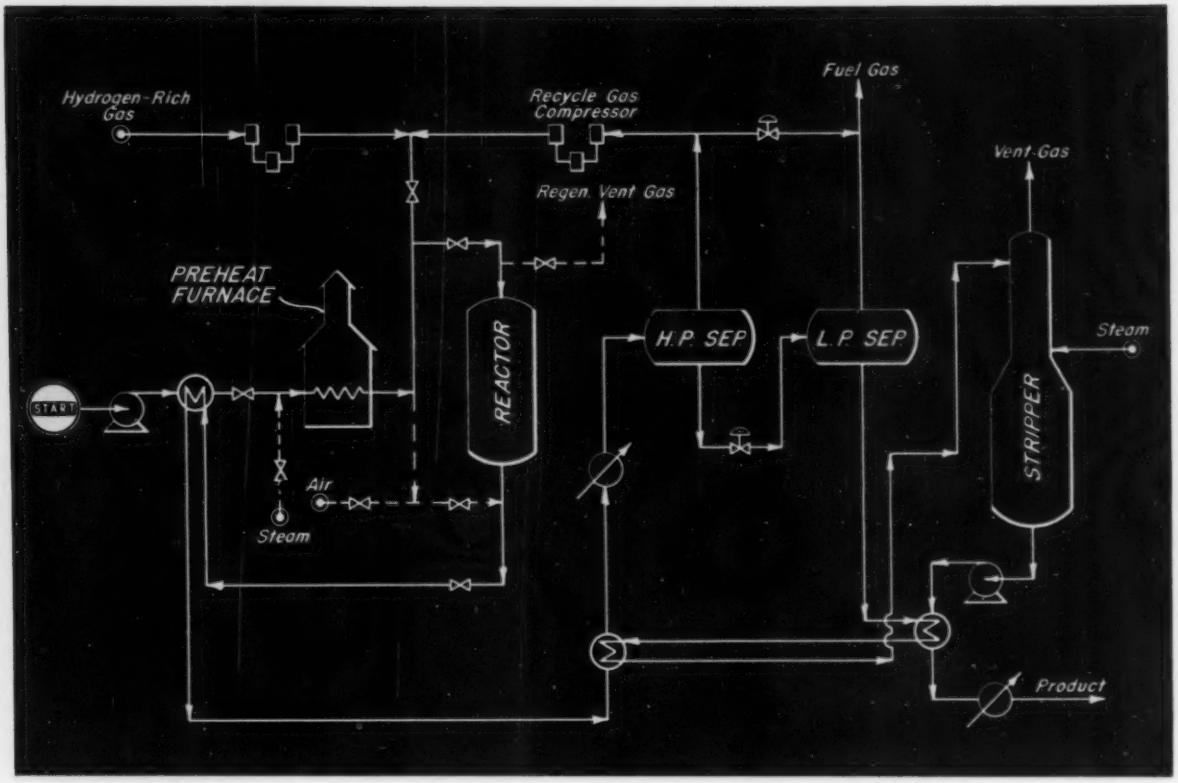
Yields: The table below shows typical product properties for the hydrodesulfurization of a Middle East light catalytically cracked gas oil:

Processing Conditions:	
Catalyst	Cobalt-molybdenum-alumina
Pressure, psia	750
Temperature, Fahrenheit	710
Liquid Hourly Space Velocity, Vol. per Vol. per Hour	3.0
Recycle-Gas Rate, scf per Barrel	1350

	Feed Stock	Product* Under 430 F	Product* 430 to 500 F	Product* 430 F Plus	Product* 500 F Plus
Percent Weight of Feed	100	9.9	20.3	87.6	67.3
Percent by Volume of Feed	100	10.7	21.3	90.4	69.1
Gravity, Deg. API	21.3	33.8	25.4	26.1	25.5
ASTM Distillation (Fahrenheit)					
Initial Boiling Point	446	270	437	475	532
End Point	650	417	480	650	650
Sulfur, Percent by Weight	2.90	0.01	0.02	0.34	0.43
Extractable with 98 Percent Sulfuric Acid, perc. by Wt.	70	87	80	.....	.....
Octane Numbers:					
ASTM, Without TEL Addition	.....	90	77	.....	.....
CFR Research, Without TEL Addition	.....	100+	88	.....	.....
Pour Point, Fahrenheit	14	.....	.....	19	25
Diesel Index	19.5	.....	.....	27.1	29.9

* Sharp Fractionation.

Reference: PETROLEUM REFINER, vol 34, no 9, p 152 (Sept, 1955).



Ultrafining—STANDARD OIL COMPANY (INDIANA)

Application: Primarily for desulfurization, denitrogenation and olefin saturation.

Charge: A variety of feedstocks ranging from naphthas to heavy catalytic cycle stocks.

Product: Materials having low sulfur, nitrogen and olefin contents and improved stability. Cycle oils possess improved catalytic cracking characteristics. Typical feed and product data are shown in Table 1.

TABLE 1—Typical Ultrafining Applications

	Pretreat Reformer Feed[1]		Make No. 1 Fuel Oil[2]		Upgrade Diesel Fuel[3]	
	Charge	Product	Charge	Product	Charge	Product
Gravity, °API	56	57	41	42	31	33
ASTM Distillation, °F.:						
IBP	175	170	346	349	368	376
10 percent	209	207	386	389	426	426
50 percent	252	251	450	446	494	489
90 percent	323	325	518	515	560	565
Maximum	375	380	552	550	626	631
Olefins, volume percent	15	1	.....	.....	.....	.....
Bromine No.	29	0.5	.....	.....	.....	.....
Sulfur, weight percent	0.32	0.0030	0.60	0.06	1.10	0.09
Nitrogen, weight percent	0.0031	0.0006	.....	.....	.....	.....
Yield, vol. percent charge	.....	100	.....	98.0	.....	95.5
400°F. EP gasoline	.....	.....	.....	2.8	.....	0.1
Sediment[4]	.....	.....	.....	.....	1.9	0.8
Color, Saybolt	.....	.....	+25	+27	.....	.....
Color, stabil., Saybolt	.....	.....	Poor	+13	.....	.....
Air-Jet Gum, mg/100 ml	.....	.....	.....	.....	83	20
Floc gum, mg/100 ml	.....	.....	.....	.....	14.4	5.3
Worrall Burner						
Side deposits	.....	.....	3	0.6	.....	.....
Bottom deposits	.....	.....	13	11	.....	.....
Odor	.....	.....	Poor	Good	.....	.....
Doctor	.....	.....	Sour	Sweet	.....	.....
Cetane No.	.....	.....	.....	.....	36.7	40.8

[1] Remove sulfur, nitrogen, saturate olefins from 60% virgin and 40% coker naphtha.
[2] Remove sulfur, reduce deposits, improve odor and color stability of W. Texas virgin heater Oil.
[3] Reduce sulfur, improve stability and cetone number of feed (84% cat. cycle oil, 16% coker gas oil).
[4] Accelerated aging, 20 hr. @ 200 F.

Description: Ultrafining is a catalytic hydrogenation process. The flow sheet illustrates a typical Ultrafining installation for processing distillates and heavier feedstocks. The reactor is charged with a cobalt-molybdenum on alumina catalyst. Depending upon feedstock, the reactions may be carried out in either the vapor or mixed phase. Catalyst is regenerated at infrequent intervals with steam-diluted air.

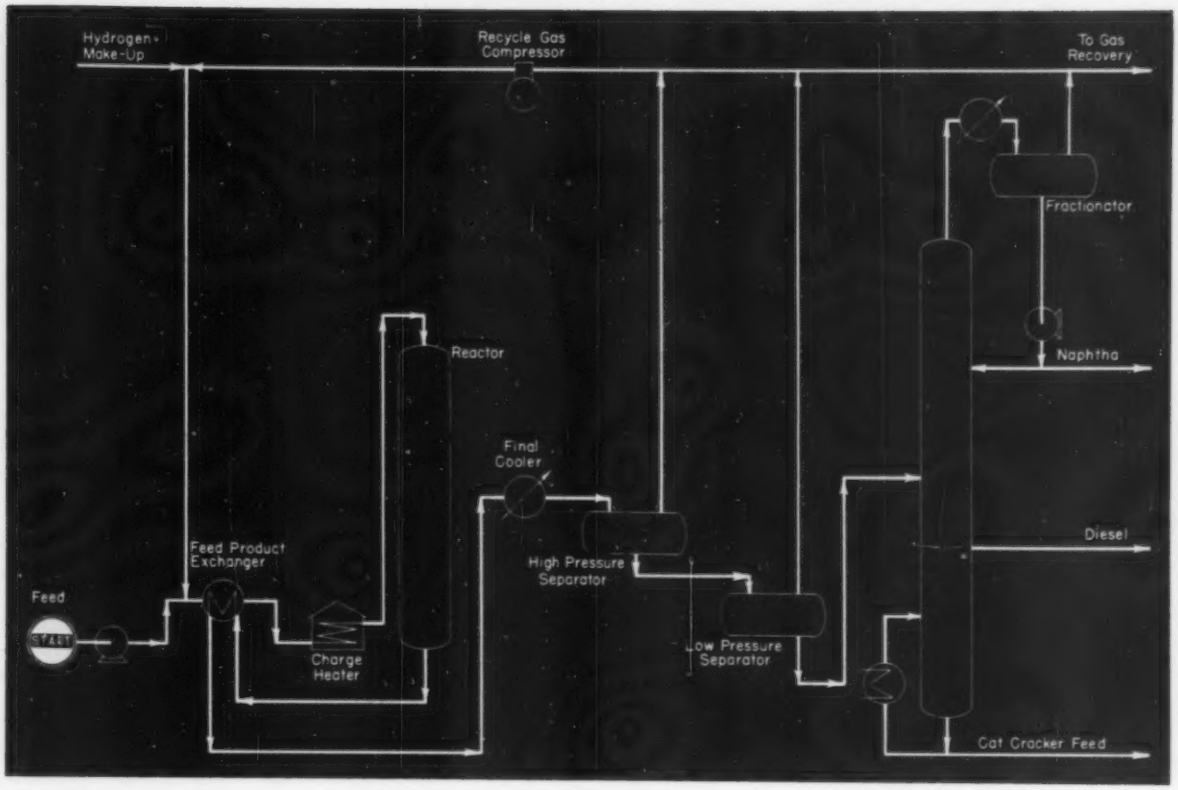
Operating Conditions: Temperatures ranging from 600-800 F., pressures from 200-1500 psig., space velocities from 1-20 v/hr/v, dilute H_2 addition rates from 500-4000 scf/bbl. and H_2 concentrations of at least 70 mole % in the hydrogen stream.

Economics: Typical labor and utilities requirements for an 8500 bpd Ultrafiner are shown in Table 2.

Commercial Installations: Including installations used to prepare feed for catalytic reforming, 23 Ultrafiners having a total capacity of about 250,000 bpd are in operation by Standard, its affiliates, and its licensees.

TABLE 2—Typical Operating Requirements
(8500 B/D cycle oil hydrogenation)

DIRECT CHARGES	
Labor, men	2–3
Maintenance, percent of plant investment/yr.	3–4
Catalyst life, bbl/lb	250
Hydrogen, scf/bbl	170
UTILITIES	
Cooling water, gpm (90–120 F.)	1860
Steam, lb/hr. 100 psig. 400 F. TT (exclusive of drivers)	2660
Electricity, kwh (exclusive of drivers)	25
Pumps and compressors, THP	220
Fuel, MMBtu/hr	21
INDIRECT CHARGES	
Royalty, paid-up, $/B/D	38
Royalty, running, $/B/D	0.015



Unifining—UNION OIL COMPANY OF CALIFORNIA AND UNIVERSAL OIL PRODUCTS COMPANY

Application: For removing sulfur, nitrogen, oxygen and other contaminants from either straight-run or cracked petroleum fractions.

Products: The objectives of Unifining include: (1) Pretreatment of catalytic reforming feedstocks; (2) Improvement in odor, color, gum and storage stability; (3) Improvement in burning properties of furnace oils, cetane number of diesel fuels, lead susceptibility of gasoline; and (4) Pretreatment of catalytic cracking feedstocks.

Description: The accompanying diagram shows an equipment arrangement for the simultaneous preparation of catalytic cracking feedstock and high quality naphtha and diesel blending stocks. The feedstock comprises mixed vacuum straight-run and coker gas oils.

The feed is combined with hydrogen recycle gas, preheated by heat exchange with reactor products and heated to the required inlet temperature. The reactor products, after heat exchange, are cooled and flow to a high-pressure separator. The hydrogen-rich gas is recycled to the reactor. In some applications gas from the high-pressure separator is passed through an absorber for removal of hydrocarbons. The high-pressure separator liquid flows to a low-pressure separator where additional gases are removed. Liquid from the low-pressure separator may be sent to a stripper, stabilizer or other comparable equipment. In this diagram liquid from the low-pressure separator is fractionated into a naphtha stream, diesel blending stock and catalytic cracking charge.

Products and Yields: Representative commercial data on a 10,000-bpsd Unifining unit are:

Unifining Gas Oils

	Charge*	Naphtha	Diesel	Catalytic Cracking Feed
Gravity, °API	31.4	61.6	34.8	26.4
ASTM Dist, °F:				
Initial	153	95	402	571
50 Percent	665	260	515	728
95 Percent	840	378	624	877
Sulfur, Wt. Percent	1.91	0.12†	0.19	0.53
Conradson Carbon	0.375	.....	0.024	0.247
Metals, ppm:				
Nickel	0.30	.....	.....	0.07
Vanadium	1.90	.....	.....	0.35

* Vacuum Distillation.
† Mostly Dissolved H_2S.

Economics: See table.

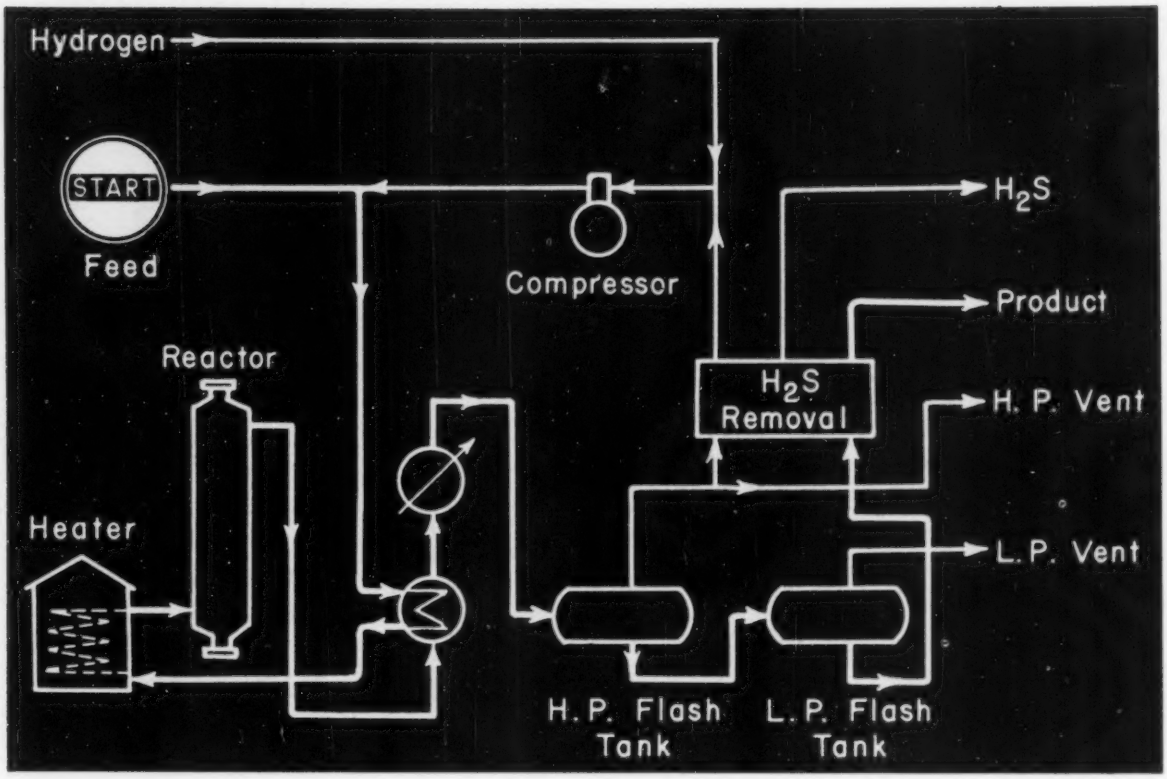
Unifining Costs

FEED	Reformer Feed	Stove Oil And Diesel	Wide-Range Distillate	No. 2 Heating Oil
Throughput, bpd	16,000	900	5,000	12,000
Direct operating costs, ¢/bbl:				
Labor and supplies, maintenance, utilities	6.3	3.7	5.7	7.7
Catalyst	0.9*	0.8*	0.8*	1.2
Total	7.2	4.5	6.5	8.9

* Original catalyst still in service. Cost based on life as of May, 1958.

Commercial Installations: The first commercial installation was made in 1953. Commercial units apply Unifining to straight-run, thermal, catalytic and coker naphthas; straight-run kerosine, diesels, and burner oils; vacuum, visbreaker, and coker gas oils; catalytic cycle stocks, aromatic distillates; and lube oils.

Reference: PETROLEUM REFINER, vol 36, no 3, p 201 (Mar, 1957).



Vapor-Phase Hydrodesulfurization—SHELL DEVELOPMENT COMPANY

Application: To treat aviation and motor gasoline blending components to produce low-sulfur, low-gum products.

Charge: Cracked naphthas and straight-run distillates.

Products: Aviation and motor gasoline blending stocks, light distillate fuel oil, and mineral spirits.

Description: The flow pattern for the process is shown in the accompanying diagram. Raw feed is mixed with hydrogen, and the combined stream is preheated by heat exchange with reactor products and then in a furnace. From the furnace the feed passes in vapor phase to the adiabatic reactor. Reactor product is heat exchanged with cold feed and sent to water coolers.

Gas remaining after the cooling step is treated for hydrogen sulfide removal and then recirculated. Makeup hydrogen is added to the recycle hydrogen. Liquid product from the high-pressure separator is first flashed at a low pressure in order to remove part of the dissolved gases, and is then treated so as to remove hydrogen sulfide. A final caustic and water wash removes last traces of hydrogen sulfide.

The catalyst for the desulfurization is supported Co-Mo. It has high activity and can be regenerated. It can selectively desulfurize cracked naphtha for motor gasoline where saturation of olefins must be minimized in order to retain high octane ratings.

Operation Conditions: Normal operating pressure is between 500 psig and 750 psig. The reactor inlet temperature is normally between 450 F. and 700 F. This temperature depends on the boiling range of the feed stock, the depth of the desulfurization, and the catalyst activity. High space velocities are used so that a small reactor will handle high charge rates. Mole ratio of hydrogen to feed is relatively low.

When thermally or catalytically cracked naphtha is the feed stock, the catalyst is regenerated only every 2 to 4 months. With a straight-run distillate feed stock, the operating period is about 10 months between regenerations. Ultimate catalyst life depends upon the physical strength of the catalyst. At one plant catalyst usage was about one pound for each 600 barrels of cracked naphtha processed.

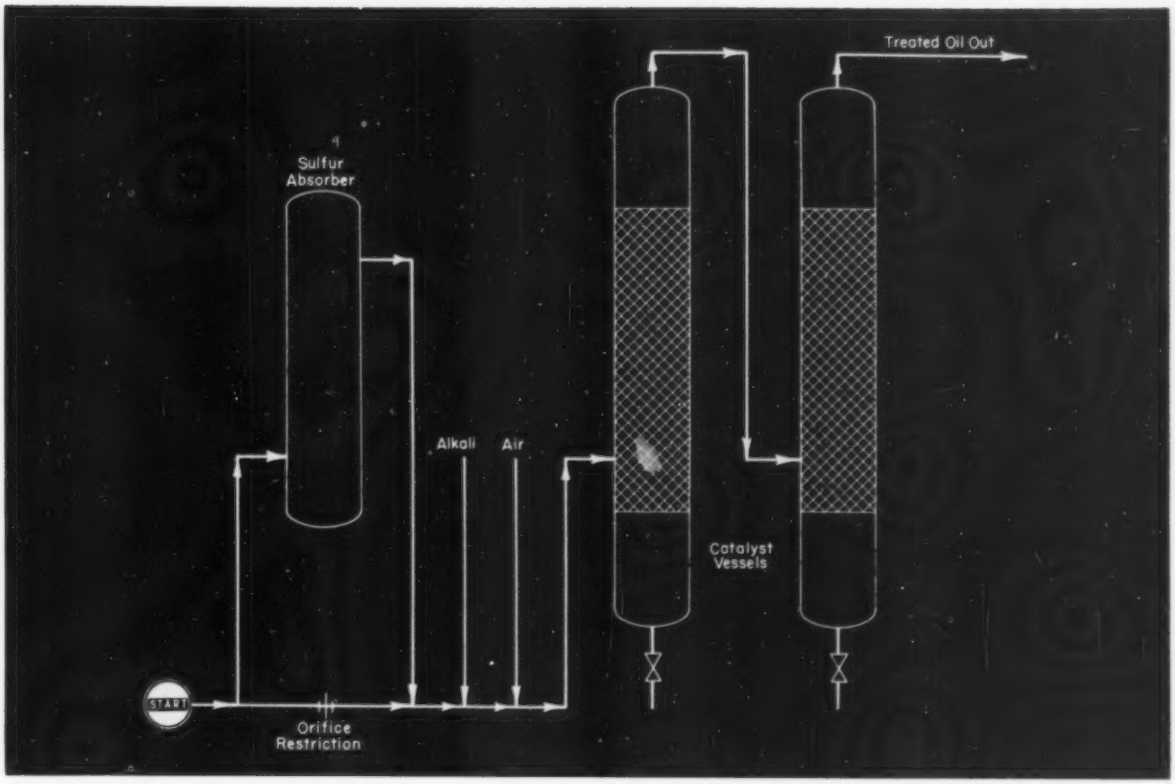
Yields: The liquid volumetric yields from this process are over 100 percent. With cracked naphthas containing 0.4 to 1.5 weight percent sulfur, the reduction in sulfur is about 60 to 70 percent. The resulting products are stable gasolines in all respects.

Economics: The estimated cost of a unit with capacity of 10,000 barrels per stream day is about $2 million, excluding offsite facilities. The direct cost of treating catalytically cracked naphtha is as follows:

Item	¢/B
Utilities	3.2
Chemical and Catalyst	1.1
Hydrogen	0.6
Labor	1.7
Maintenance	2.4
Overhead	4.1
Total	13.1

Commercial Installations: One at Dominquez, Calif., and one at Wood River, Ill.

Reference: PETROLEUM REFINER, vol 34, no 6, p 118 (June, 1955).



Bender—PETRECO DIVISION, PETROLITE CORPORATION

Application: Sweetens distillates, and is particularly applicable for the reduction of mercaptan sulfur in the range of 0.004 to 0.08 weight percent.

Charge: Distillate streams such as gasoline, kerosine, jet fuel, No. 2 fuel oil. It is especially effective in the kerosine-No. 2 fuel oil range.

Product: A sweet, bright, non-corrosive distillate.

Description: Sweetening is accomplished by converting mercaptans to disulfides in the presence of a fixed bed catalyst. Sulfur is added to the distillate, plus a small amount of alkali (caustic or doctor solution) and air. This mixture is then passed over a bed of solid catalyst. The distillate passes through the catalyst bed rapidly, at rates up to 12 inches per minute.

Hydrogen sulfide must be removed from a distillate prior to Bender Sweetening to maintain the catalyst activity. A caustic prewash can be employed.

When the catalyst has become inactive, it may be reworked at the plant site or replaced by new catalyst.

Some of the process advantages are:

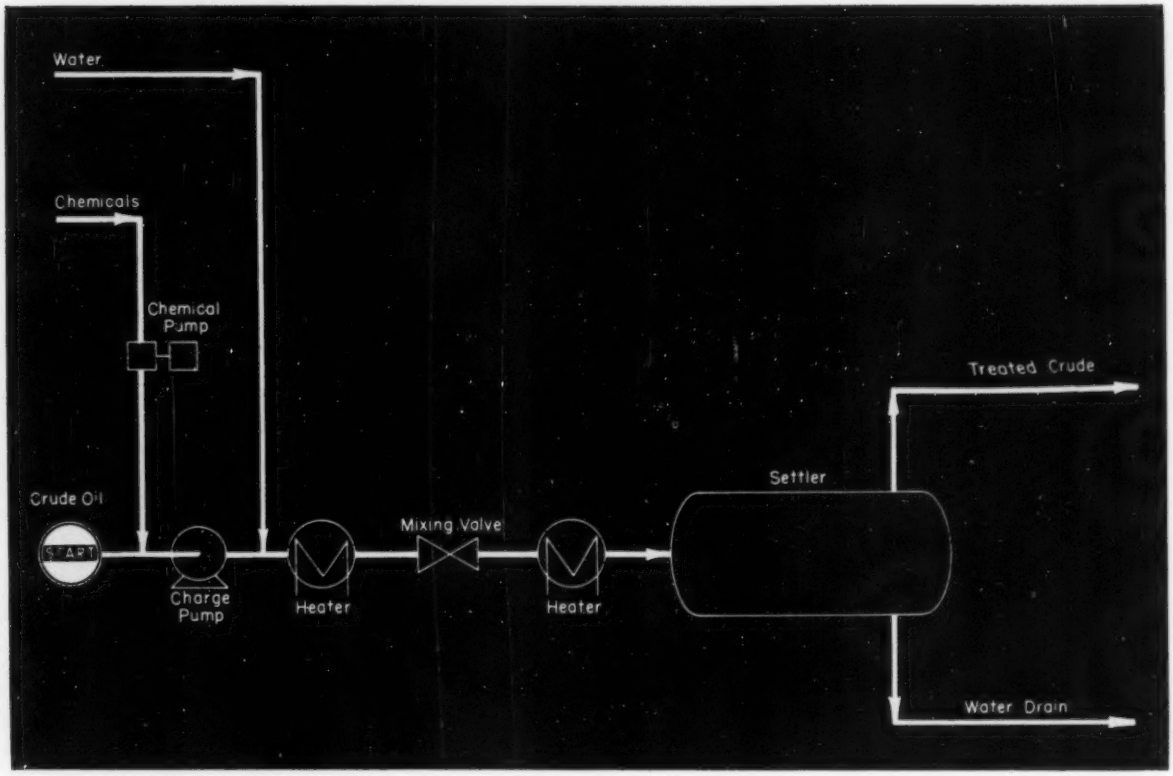
- Simplicity of Operation.
- Low Operating Costs
- Uniformly Sweet and Non-Corrosive Product
- Eliminates Pollution
- No Product Loss
- No Continuous Regeneration
- Low Installation Cost
- Small Plant Area Required

Operating Conditions: Gasoline and naphthas, in general, require 1.0 to 1.25 theoretical equivalents of sulfur. Kerosines, light gas oils, etc., require 1.5 to 2.0 theoretical equivalents. A small amount of caustic is added to the distillate to maintain the effluent in a slightly alkaline state. Air requirements are moderate; and may be supplied from instrument air systems for smaller distillate streams. The operating temperature depends on the distillate to be processed: gasoline is about 90° F, stove oils approach 140° F. Normally, a back pressure of 20 psi minimum is maintained on the unit.

Economics: Installation cost for this process is estimated to be in the range of $15 to $30 per barrel per day of thruput. The total treating costs, excluisve of amortization, average close to 0.5 cents per barrel of change. Making up this cost are such items as labor, catalyst maintenance, sulfur, NaOH and utilities. The amortization costs will vary from plant to plant, but a spread of 0.5 to 1.0 cents per barrel of daily charge will cover most cases. Amortization is calculated on a basis of ten years. If total treating costs and amortization costs are added, the over-all expense of a Bender treating plant will average under 1.5 cents per barrel.

Commercial Installations: Sinclair Refining Company and its affiliates have four units in operation. Since Petreco has been designated as exclusive sublicensors, eight more plants have been installed.

Reference: PETROLEUM REFINER, vol 34, no 9, p 182 (Sept, 1955).



Chemical Desalting

Application: To remove inorganic salts from crude oil so that these salts will not be present to cause plugging of exchangers, coking of furnaces, and corrosion. The process also provides removal of arsenic and other trace metals which act as poisons to catalytic cracking catalysts.

Charge: Crude oil

Product: Crude containing 10-20 percent or less of the original concentration of organic salts. The goal for this process is a treated crude having five to ten pounds or less of salts per thousand barrels.

Description: The salts normally present in a crude oil can be retained in a refinery charge as crystalline suspensions and as entrained solutions with water. These salts break down during processing to form acids which increase corrosion. They also deposit in exchangers and tube stills to limit flow and cause hot spots. Some of the metallic constituents of the salts as catalyst poisons.

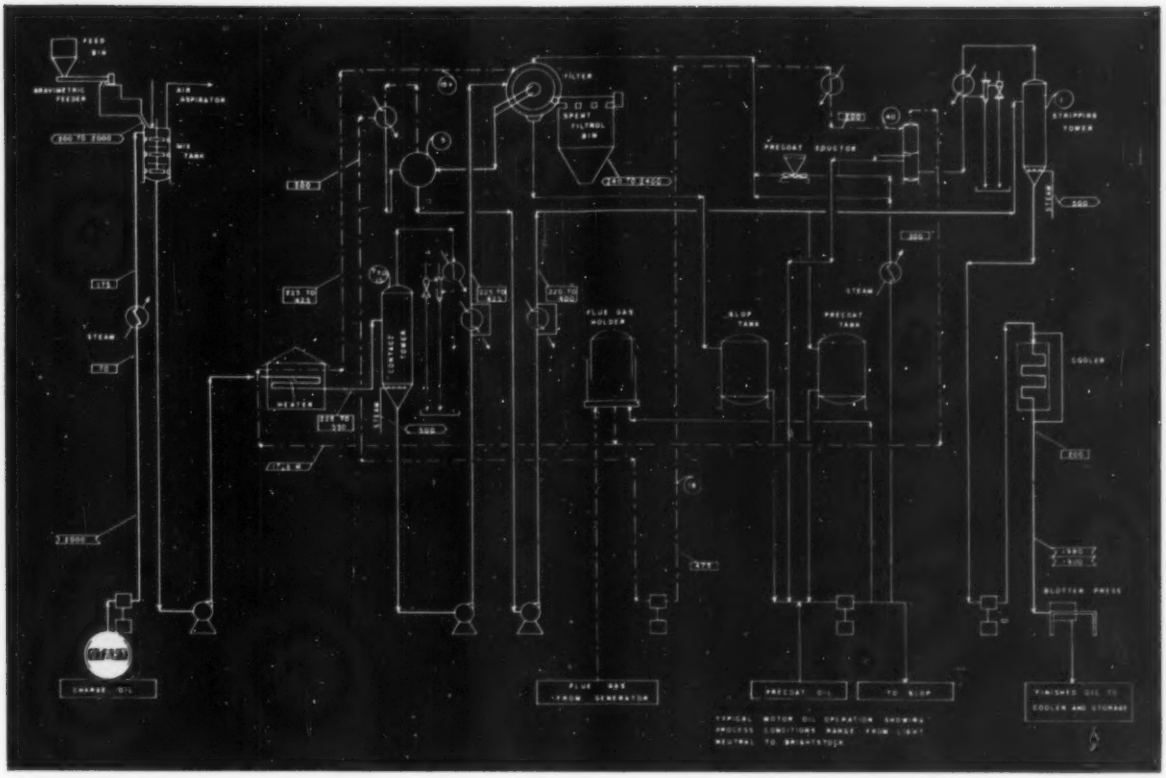
The salts are held in the crude oil by an organic film. They can be separated from the oil by water washing in the presence of special chemicals tailored to suit the type of salts present and the nature of the crude oil. The accompanying flow diagram shows a typical chemical desalting process.

The chemicals are added to the process stream with a pump which is usually of the positive displacement type. They are added upstream from the charge pump so they will become thoroughly mixed with oil. Caustic or acid may be part of the chemical mixture or either may be added separately later to adjust the pH of the solution.

Process water is used to dissolve the salts not already in solution. To assure good contact between the water and the crude, they are passed through a mixing valve to form an emulsion. In some cases the water is added upstream from the charge pump so that the emulsion is formed by the pump impellers.

The process is carried out at elevated temperatures. The temperatures vary from 150 to 350 F. depending upon the type of crude being processed. The heat lowers the surface tension of the oil, allowing water particles to coagulate easier. The heat also reduces the viscosity of the oil, giving less resistance to separation of the salt laden water.

A settler provides a quieting zone following the heat exchangers. The settler is often designed to allow settling times from 20 to 60 minutes. It may be equipped with heating elements to maintain the elevated temperatures and with baffles to reduce flow turbulence and channeling. Crude oil leaves the top of the settler while salts are withdrawn as a solution with the drain water.



Continuous Contact Filtration—FILTROL CORPORATION

Application: Principally for the refining of lubricating oil stocks, but it is also applied successfully to the finishing of waxes and specialty oils.

Charge: Petroleum hydrocarbons in the lubricating oil or specialty oil range that have been solvent extracted, acid treated. Solvent extracted stocks are dewaxed, usually, before charging.

Product: Finished lube oil or specialty oil base stocks ready for blending and compounding.

Description: The flow diagram shows the operating conditions (minimum and maximum) for a hypothetical unit processing motor oil base stocks ranging in viscosity from light neutrals to bright stocks at an average rate of 2,000 barrels per day. Larger and smaller feed rates are employed also.

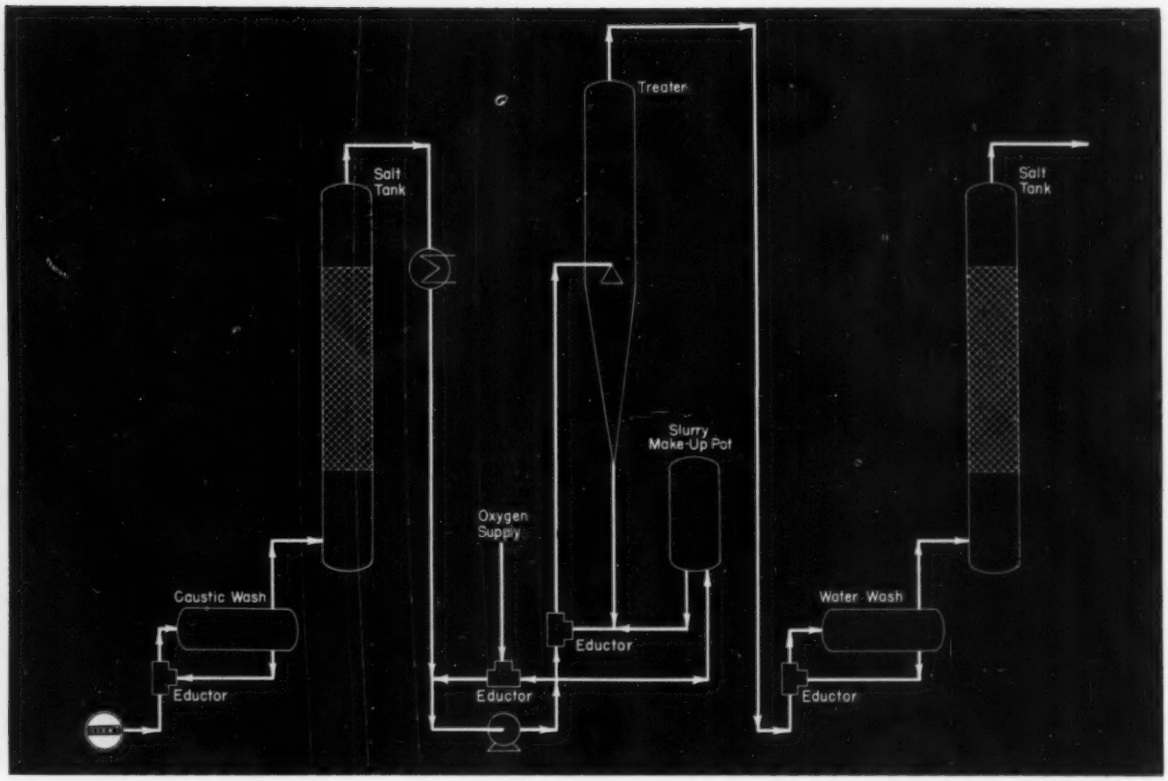
The adsorbent is added to the oil charge and the oil-adsorbent slurry enters a pipe still heater where maximum contact temperature is obtained in a once through operation. From the heater the slurry enters a stripping tower where a level is maintained regulating the time of contact. Steam is passed through the slurry and up the tower to facilitate the stripping action. The slurry is drawn continuously from the bottom of the tower to a vacuum filter. The filtered oil is charged to a high vacuum stripper to furnish additional product control. The oil is finally pumped through a blotter press, cooler and to storage.

Yields: Yields are a function of the type of oil charged and the quantity of adsorbent used. Normally, yield approximates 98.5 percent of oil charged.

Contact filtration is a mild refining step, polishing and decolorizing the oil and improving inspections such as carbon residue, oxidation, neutralization number and emulsibility-demulsibility.

Typical Inspections of Lubricating Oils

Determination	Turbine Oil		Phenol Raffinate	
	Before Contact Filtration	After Contact Filtration	Before Acid Tr. and Cont. Filt.	After Acid Tr. and Cont. Filt.
Gravity, °API	23.0	23.1	22.6	22.6
Color, ASTM	3	2	4	1½
Viscosity, S.S.U. @ 100 F.	508	495	372	364
Flash, °F	395	410	395	400
Fire, °F	455	455	440	440
Neutral No.	0.03		0.9	0.02–
Steam Emulsion No.	1200+	20–	.....	.....
Conradson Carbon Residue	.....	.....	0.03	0.02



Copper Sweetening—LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Application: For converting organic mercaptans to disulfides.

Charge: Straightrun gasoline, thermally and catalytically cracked gasolines, kerosines, special solvents, and distillates.

Description: The first step in this process is the removal of hydrogen sulfide. This can be done by bringing the sour hydrocarbons into contact with a solution of sodium hydroxide or sodium carbonate in conventional equipment.

The sour hydrocarbon stock is then passed through a salt tank for removal of excess moisture and then flows through a heater where the temperature is increased (about 5 to 25 F.) to an amount sufficient to enable the stock to dissolve the water formed in the sweetening reaction.

From the heater, the sour hydrocarbons flow to the suction of a centrifugal pump. About 10 percent of the total stock flows through an eductor into the suction side of the pump. Pure oxygen, for regeneration of the copper chloride, is constantly added to this bypassed portion of the stock at the suction side of the eductor, and this portion of stock flows through the pump with the main stream where it goes into solution and becomes uniformly dispersed.

The total throughput of the hydrocarbons containing the dissolved oxygen is discharged from the centrifugal pump through an eductor, the suction side of which is connected to the bottom of the cone of the treating tank. The copper chloride, clay and hydrocarbons flow as a slurry from the bottom of the treating tank into the eductor. Here the slurry contacts intimately the oxygen and sour hydrocarbons and the chemicals which results in immediate sweetening of the hydrocarbons. Rapid regeneration of the copper chloride is achieved. When necessary fresh clay and copper chloride can be added by way of the slurry make-up pot.

The slurry mixture flows through a return line into the treating tank, where the copper-chloride clay mixture settles to the bottom to be used again and the sweetened stock flows up and out the top. From the treating tank, the stock passes through a water wash tank and then through a final salt tank for removal of the entrained water.

For straightrun gasoline, no further treatment is required. In the case of cracked gasoline, however, and in some cases kerosine, a small amount of metal deactivator is added to counteract the possible detrimental effect of dissolved copper compounds.

In brief, the major advantages are: (1) tetraethyl lead savings, (2) higher quality products, (3) lower operating costs, and (4) elimination of material losses.

General Operating Specifications

Precaustic Wash Tank—for Removal of H_2S:
Sodium Hydroxide Solution—5% to 10% by weight
Settling time—45 to 60 minutes (gasoline) or 45 to 75 minutes (kerosine or No. 1 heating fuel).
Contact ratio, sodium hydroxide solution to stock—1:4

Salt Tank—for Removal of Suspended Liquid: Maximum velocity through salt, based on empty tank—75 ft/hr. (gasoline) or 30 ft./hr. (kerosine or heating oil).
Quantity of salt, (minimum)—30 lbs./bbl./hr. (gasoline) or 75 lbs./bbl./hr. (kerosine or heating oil).

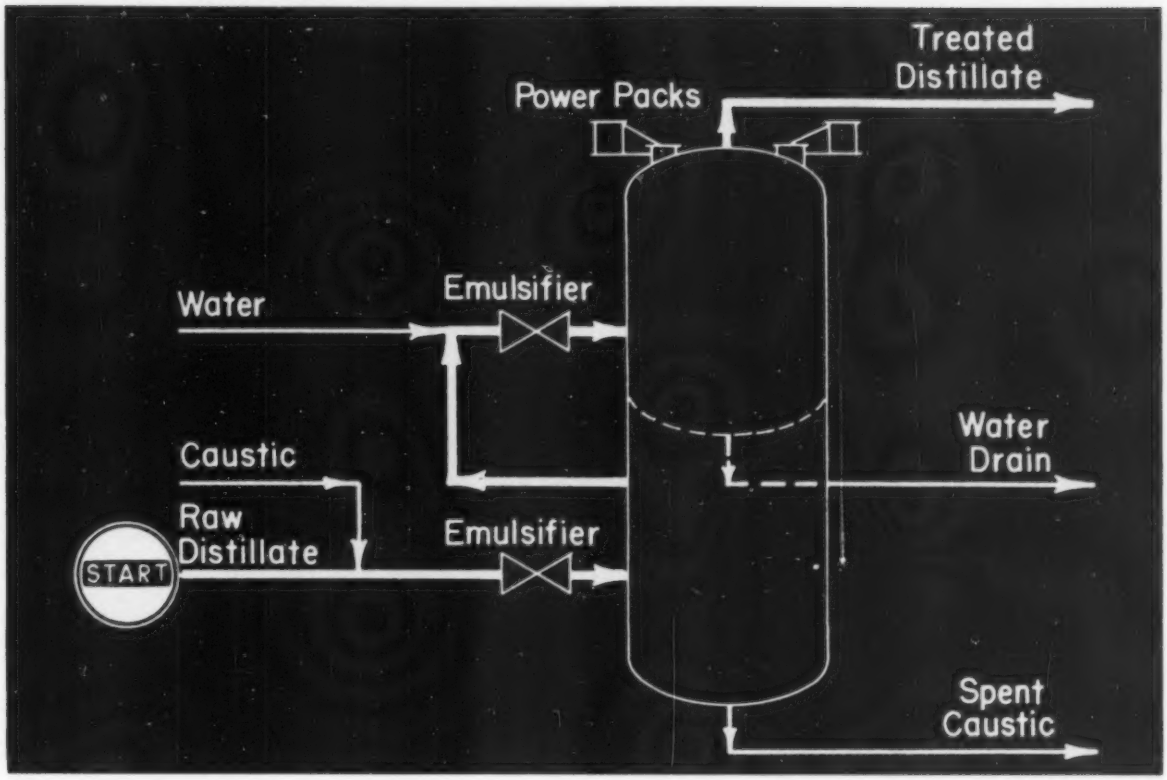
Oxygen: Theoretical oxygen required—0.01 cu. ft./bbl./hr./mg. mercaptan S/100 cc. or 0.07 cu ft./bbl./hr./0.01% mercaptan S for 0.7 specific gravity.
Actual oxygen consumption 1½ times theoretical.

Treating Tank: Maximum velocity above cone—
Straight run gasoline, acid treated cracked gasoline and similar stocks—5"/min.
Kerosine, No. 1 heating fuel, raw pressure distillate, thermally and catalytically cracked gasoline and poly gasoline—3"/min.
Settling time above cone—24 to 40 min.
Concentration Cupric Chloride in Slurry:
10% by wt. for less than 10 mg. mercaptan S/100 cc
15% by wt. for 10 to 20 mg. mercaptan S/100 cc.
20% by wt. for more than 20 mg. mercaptan S/100 cc.
Water of Reaction: $2\ RSH + O \rightarrow R_2S_2 + H_2O$
1 mg./100 cc. RSH = 3.9 PPM H_2O
Discharge pressure at centrifugal pump: approx. 100 psig.
Pressure drop across eductor: 60 to 80 psi.
Pressure in treating tank: 20 to 40 psi.

Water Wash Tank: Settling time—30 to 45 min. (gasoline) or 45 to 75 min. (kerosine or No. 1 heating oil).
Contact ratio, water to hydrocarbon stock—1:4

Sodium Sulfide Wash: Composition: 6 to 10% Caustic Soda
3 to 6% Sodium Sulfide
Settling time—45 to 60 min. (gasoline) or 45 to 75 min. (kerosine or No. 1 heating fuel).
Contact ratio, sodium sulfide solution to stock—1:3

Deactivator: The quantity of deactivator required varies from ¼ to 2 lbs. per 1,000 barrels of processed stock. Variation depends on copper content and nature of stock.
1 lb. deactivator per 1,000 bbls. = 3.8 ppm.



Distillate Treating—PETRECO DIVISION, PETROLITE CORPORATION

Application: For contacting a light hydrocarbon stream with a treating agent (acid, caustic, doctor, etc.) then separating the chemical phase from the treated hydrocarbon product.

Charge: Light hydrocarbons such as gasoline, kerosine, diesel fuel, jet fuel, furnace oils, transformer oils and lube distillates.

Product: Treated light hydrocarbons, free from carry-over, stable, ready for blending or shipping.

Description: Treating chemical such as acid, caustic or doctor solution is dispersed into the hydrocarbon stream to be treated. The volume of chemical dispersed, the degree of dispersion desired, and the time and intensity of contact are all automatically controlled. The chemical-hydrocarbon mixture is then subjected to the action of the electrostatic field in an Electrofining treater. The electric field coalesces the dispersed phase; the acid sludge, spent caustic or doctor solution then separates from the continuous phase.

The process is extremely flexible, with options of single-stage or two-stage treaters available. Various concentrations of caustic can be efficiently applied and separated. Acid treating, or acid-acid sludge treating in series can be effected. Doctor treating, three phase treating, sulfonation and water washing are other possible alternatives. The flow diagram illustrates one of the many broad applications possible.

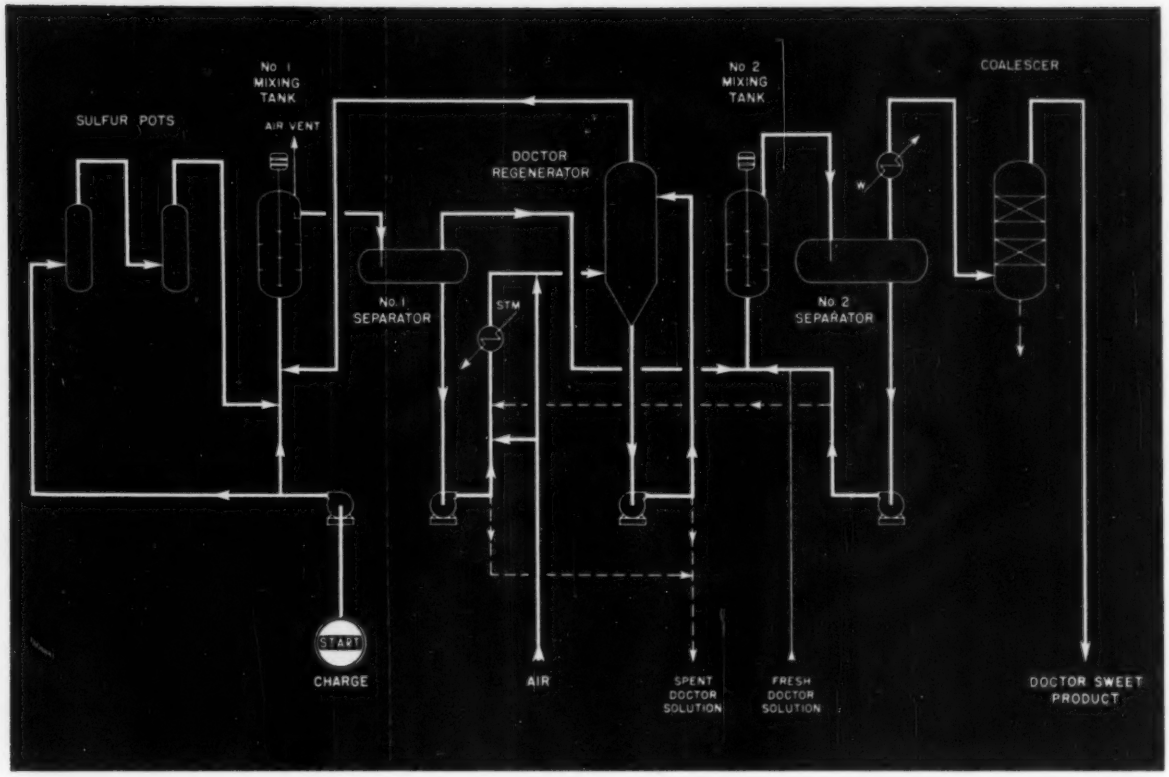
Operating Conditions: Electrofining treaters operate at the normal temperatures at which the hydrocarbon to be treated flows to the run down tanks or storage. A pressure of 25 psi, or more, is required to hold the hydrocarbons in a liquid phase. A power consumption of about 1 kw is normal at the usual power voltage of 460 volts, 60 cycles.

Yield: The product quality varies with the hydrocarbon processed and the treating agent. However, in plants currently operating, it can be stated that the products are usually characterized as doctor sweet, stable in color, low in metal ions and RSH, free from carry-over and capable of passing the usual specification tests.

Economics: Treaters varying in size from 400 bpd to 40,000 bpd have been installed at a total cost of $5 to $20 per daily barrel charge.

Commercial Installations: There are 106 Electrofining treaters in operation or under construction, processing 77 streams in North America and abroad.

Reference: PETROLEUM REFINER, vol. 34, no 9, p 184 (Sept, 1955).



Doctor Sweetening—THE LUMMUS COMPANY

Application: To sweeten gasoline, solvents, and kerosine by converting mercaptans to disulfides.

Charge: Sour hydrocarbon stocks including gasoline, solvents and kerosine.

Description: Doctor sweetening, one of the oldest processes for sweetening gasoline, solvents and kerosine, converts mercaptans to disulfides using sodium plumbite and sulfur,

$$2\ RSH + Na_2\ PbO_2 \rightarrow PbR_2\ S_2 + 2NaOH$$
$$PbR_2\ S_2 + S \rightarrow PbS + RSSR.$$

The PbS is converted back to $Na_2\ PbO_2$ by air blowing in caustic soda.

$$PbS + SO_2 + 4NaOH \rightarrow Na_2\ PbO_2 + 2H_2O + Na_2SO_4$$

In this process, sulfur and caustic soda are consumed. In addition, some PbO is mechanically lost and some must be added to replace solution discarded because of the accumulation of sodium sulfate and sodium salts of cresols and aliphatic acids.

In this unit, a slipstream from the charge stream passes through sulfur pots, and rejoins the main charge stream along with regenerated doctor solution and regeneration air at the bottom of the No. 1 doctor mixer. The sour charge, sulfur solution and regenerated doctor solution are intimately mixed in the No. 1 doctor mixer. Air is vented from the top of this mixer, and the treated charge plus doctor solution flow out through a side nozzle to the No. 1 doctor separator.

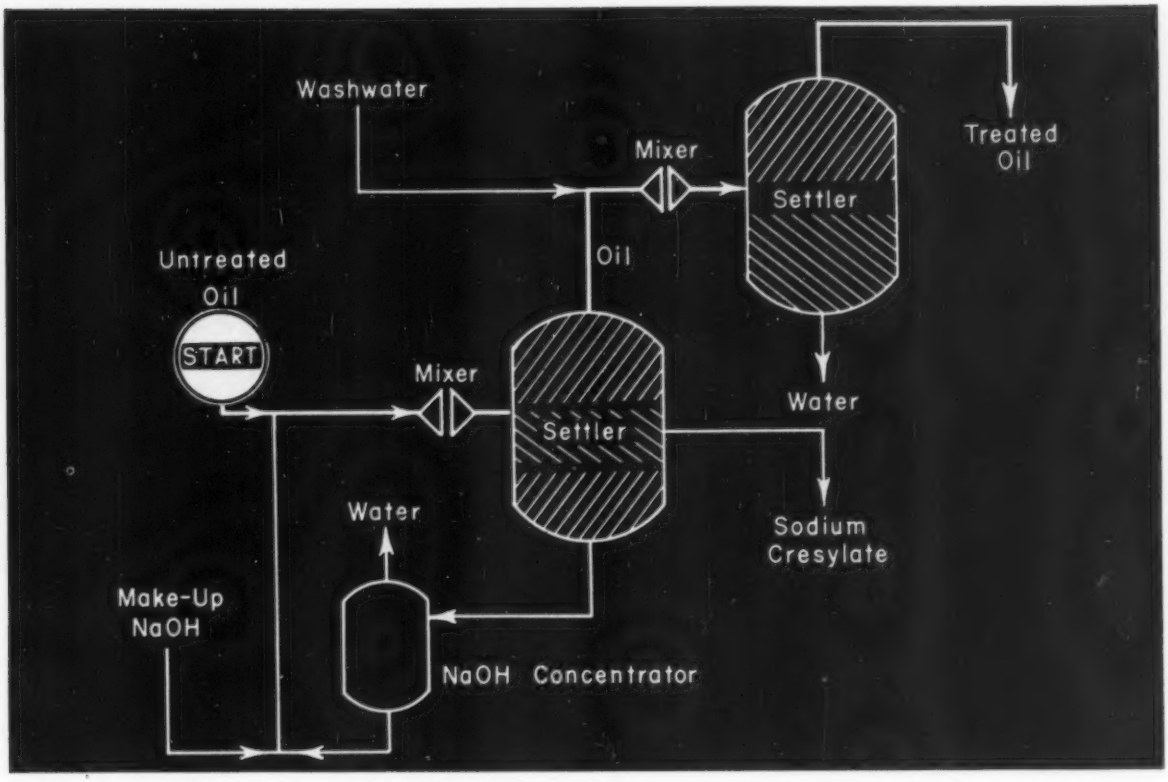
The hydrocarbon stream leaving this separator is combined with second stage doctor solution and mixed in the No. 2 doctor mixer, and then enters the No. 2 doctor separator where most of the doctor solution and lead sulfide formed in the sweetening reaction settle out.

The sweetened stock leaving the No. 2 separator is cooled in the product cooler and passes through the coalescer where residual doctor solution and lead sulfide are removed. Doctor solution from the No. 1 separator is normally circulated through the doctor heater and regenerator, combined with the regeneration air, and delivered back to the No. 1 mixer.

Doctor solution from the No. 2 doctor separator is normally returned directly to the No. 2 mixer. Periodically this solution is pumped forward to the No. 1 mixer and replaced with fresh doctor solution from storage. When this is done an equal volume of spent solution from the No. 1 separator is discarded.

Doctor solution is continuously circulated from the bottom of the regenerator to a nozzle located in the side of the regenerator by means of the doctor pump. This circulation prevents lead sulfide from settling out in the regenerator.

Reference: Petroleum Refiner, vol 30, no 1, p 138 (Jan, 1951).



Dualayer Distillate Process—MAGNOLIA PETROLEUM COMPANY

Application: To reduce sulfur content and improve color, odor, oxidation stability and inhibitor response of distillate fuel oils and similar products. The carbon residue, sediment and metals content and the tendency to form cloud in storage are lowered. These improvements are obtained by removing from the oil less than 1 percent of the highly objectionable materials like mercaptans and oxygenated compounds. The cracked distillates treated by this process become compatible with the straight-run distillates.

Description: Fuel distillate charge is mixed with concentrated caustic solution and passed into an electrical precipitator settling vessel where three layers are formed. The upper layer is treated oil, the middle layer contains the impurities combined with caustic and the lower layer is the unspent caustic.

Treated oil is washed with water and pumped to storage. The middle layer consisting of organic salts is withdrawn from the system. The lower layer, along with fresh caustic make-up, is recirculated through the unit. Traces of water produced by the chemical reactions are removed by passing a portion of the caustic solution through a small vacuum concentrator.

Operating Conditions: Typical operating conditions for the unit are shown in the following table.

Oil Rate, bpd	15,000
Temperature Inlet Oil, °F.	130
Caustic Treat	
Dosage, volume percent of oil	5
Mixer Pressure Drop, psi	15
Solution Strength, wt. % of NaOH	42
Water Wash	
Dosage, volume percent of oil	10
Mixer Pressure Drop, psi	25

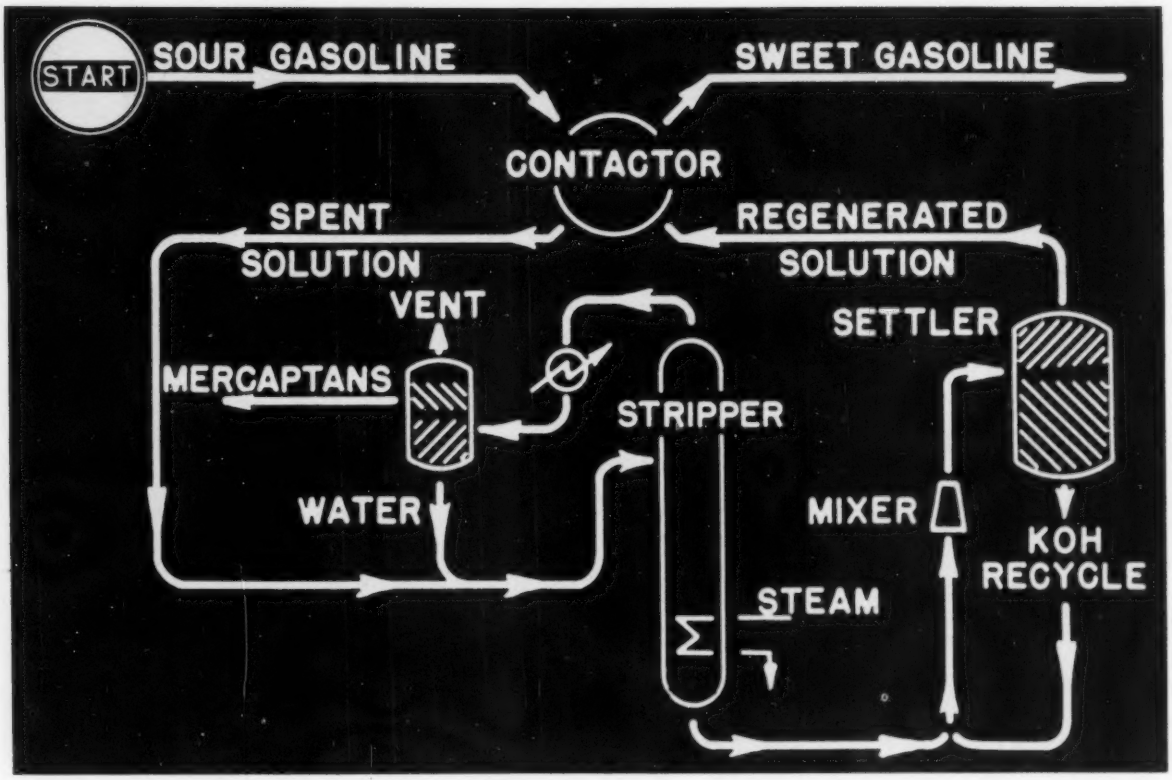
Yields: Charge and products properties of a typical cracked fuel oil distillate are shown in the following table.

Properties	Untreated	Treated
Gravity, °API	27	27
Color, ASTM	1½	1½
Mercaptan Sulfur, wt %	0.01	0.001
Carbon Residue[1], wt %	0.10	0.07
After One Year Storage Equivalent[2]		
Carbon Residue[1], wt %	0.49	0.21
Color, ASTM	8	4
Sediment, mgs./100 ml	17.3	2.5

[1] On 10% bottoms
[2] Based on Gulf Coast temperatures

Commercial Installations: Two 15,000-barrel units at the Beaumont refinery of Magnolia Petroleum Company in Beaumont, Texas, and two 10,000-barrel units at Eastern States Refinery, Houston.

Reference: PETROLEUM REFINER, vol 34, no 9, p 141 (Sept, 1955).



Dualayer Gasoline Process—MAGNOLIA PETROLEUM COMPANY

Application: To remove mercaptans and other objectionable acidic compounds from butane, gasoline, naphtha, jet fuels and similar petroleum distillates. The sulfur content of these distillates is reduced and the extracted products have a high stability, good odor and an excellent response to tetraethyl lead.

Description: The gasoline entering the unit is washed with a dilute caustic solution to remove hydrogen sulfide and other easily extractable substances. The gasoline is then contacted in two or three stages with 3 percent by volume of the Dualayer solution, washed with a small quantity of water and pumped to storage. The Dualayer solution is a strong solution of sodium or potassium hydroxide, depending on the nature of the stock treated, and contains a solubilizing agent.

The spent Dualayer solution is regenerated for reuse by diluting it in a stripper where mercaptans and excess water are distilled off, and adding makeup caustic solution.

No disulfides are formed in the product by oxidation of mercaptans. Refining costs are exceptionally low (approximately 2 cents per barrel) and the process is automatic and requires minimum supervision.

Commercial Application: Four extractor units with one regenerating unit, treating 40,000 barrels per day of gasoline, are successfully operated by Magnolia Petroleum Company at the Beaumont refinery, Beaumont, Texas.

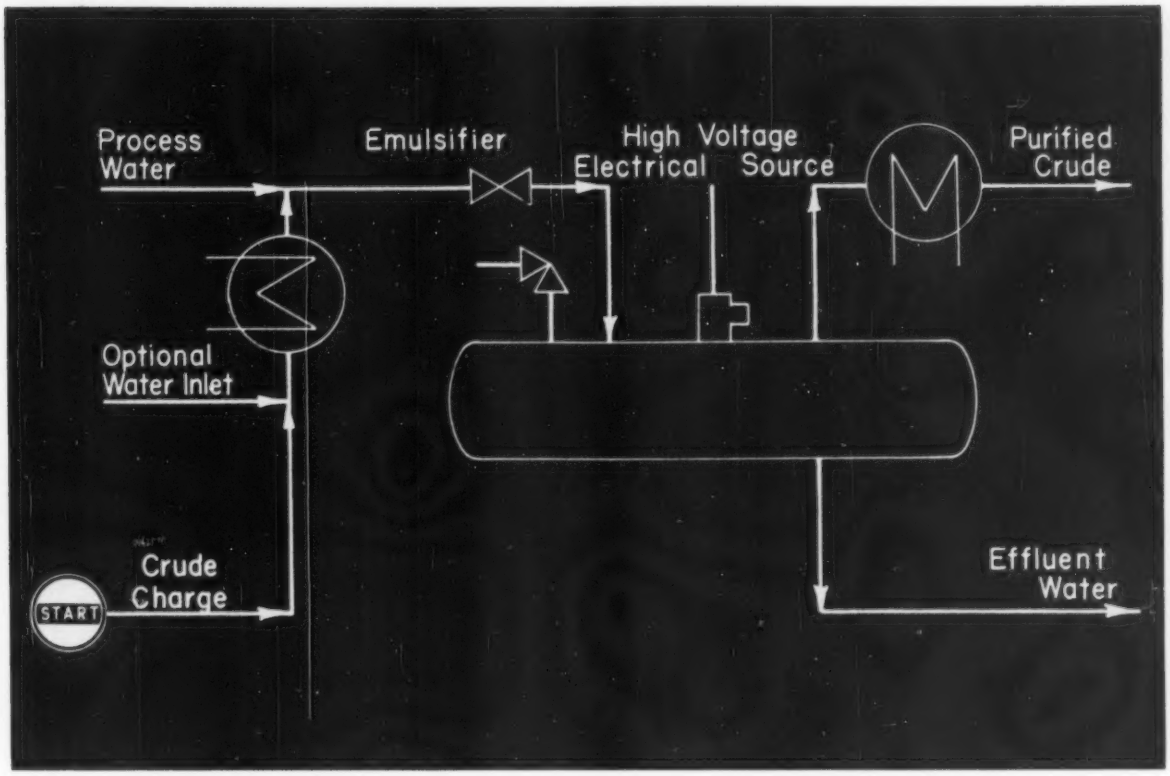
Operating Conditions: Typical operating conditions for the unit are shown in the following table.

Oil Rate, bpd	40,000
Extractor Temperature, °F.	110
Dualayer Solution	
Rate, bpd	1,200
Dosage vol percent of oil	3.0
Mixer Pressure Drop, psi	10
Dilution Water Rate, bpd	700
Stripper	
Top temperature, °F.	240
Bottom Temperature, °F.	340
Pressure, psig	12
Oil Loss, vol percent of charge	Less than 0.1

Yields: Charge and product properties are shown in the following table.

	Charge	Product
Gravity, °API	71.2	71.0
Mercaptan Sulfur, wt. %	0.091	0.001
F-1 O.N. + 3 cc TEL/Gal.	83.4	87.1
ASTM Distillation, °F.		
IBP	98	97
10%	130	128
50	164	165
90	230	232
EP	320	323
Recovery, %	98	98
RVP, psi	11.6	11.5
Color, ASTM	30	30
Sulfur, wt %	0.16	0.07

References: Industrial and Engineering Chemistry, vol 49, p 1938 (Dec, 1957).



Electric Desalting—PETRECO DIVISION, PETROLITE CORPORATION

Application: Pre-refining purification of crude oils used as refinery charging stock. Removes salts, sediment and other impurities by means of electric precipitation.

Charge: Any crude oil used as a refinery charging stock.

Product: A purified crude charge in which salts such as chlorides, sulfates, and bicarbonates, and solids such as sand, silt and rust particles are reduced to such a degree that refinery operations are unhampered. Arsenic also is substantially reduced.

Description: In the refinery, the Petreco Desalter is an integral unit in the flow plan. In operation, charging crude from refinery storage is pumped into the Petreco unit after first passing through a primary heat source. After heating, the crude is mixed, under controlled conditions, with a small quantity of fresh water to form a water-in-oil emulsion. The emulsion then is dispersed into a high potential electrostatic field in the treating section. The powerful coalescing forces of the electrostatic field cause the impurities (salts, solids, etc.) to be intimately associated with the fresh water. As this association is accomplished, the water, now serving as a carrier for the impurities, is separated rapidly from the oil and withdrawn. The purified crude oil continues on in normal refinery flow.

The three vessel types available are designated as Cylectric, Electrosphere and Vertelectric. Space requirements are nominal, depending on the type of Petreco unit installed, varying approximately from 150 to 1500 square feet.

Cylectric desalters are cylindrical, set in a horizontal position. They usually are 10 or 12 feet in diameter, the length varying according to treating capacity desired. Cylectric units are ideal for throughputs in the 10,000 to 100,000 barrel per day range, and are especially suitable where high operating pressures are desirable.

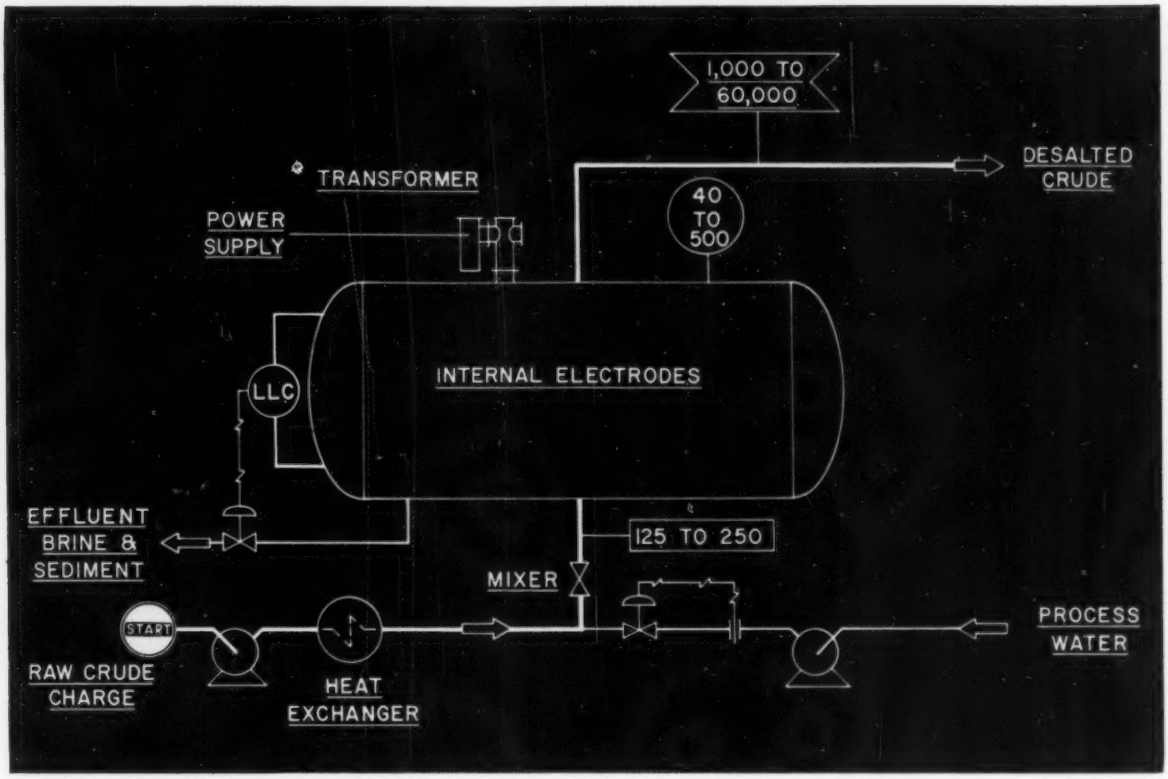
Electrospheres range in diameter from 10 to 36 feet. They have high throughput capacities, yet occupy minimum ground space. Individual Electrospheres currently are desalting up to 125,000 bpd.

Vertelectric desalters are cylindrical, set in vertical position. They are 10 feet in diameter, by about 15 feet over-all in height, with a volumetric capacity of approximately 180 barrels. Treating capacities vary from 2000 to 5000 bpd. Vertelectric desalters are designed to handle the desalting requirements of small refineries.

Operating Conditions: Normal operating temperatures are in the 180-300 F. range; optimum temperature depends on the crude. Operating pressures vary according to the type of unit used, and are in the 50 to 300 psi range. The oil-water level, rate of flow, rate of disposal and power supply are automatically regulated by pre-set controls.

Commercial Installations: There are over 250 streams being desalted in North America and abroad.

Reference: PETROLEUM REFINER, vol 32, no 9, p 125 (Sept, 1953).



Electrical Desalting—HOWE-BAKER ENGINEERS, INCORPORATED

Application: To remove salts and other impurities.

Charge: Crude oil.

Description: Fresh water is added to the raw crude at the rate of 4 to 8 volume percent of the oil rate to dissolve and absorb impurities. This water is mixed under controlled conditions with the crude to form a stable emulsion. The water-in-oil emulsion thus formed is resolved by introducing it in to a high voltage electrostatic field inside the vessel. The action of this field is to agglomerate the dispersed water phase and force it to accumulate in the lower portion of the drum. The water which contains the various impurities removed from the crude is continuously discharged to the effluent system.

Clean desalted crude flows from the top of the vessel to the refinery flow circuit.

Provision is made for injecting small quantities of demulsifying chemical. Although not continuously required for all types of crudes, it provides flexibility so that tank bottoms, slop oils and oils with abnormally high suspended solids can be processed with maximum efficiency.

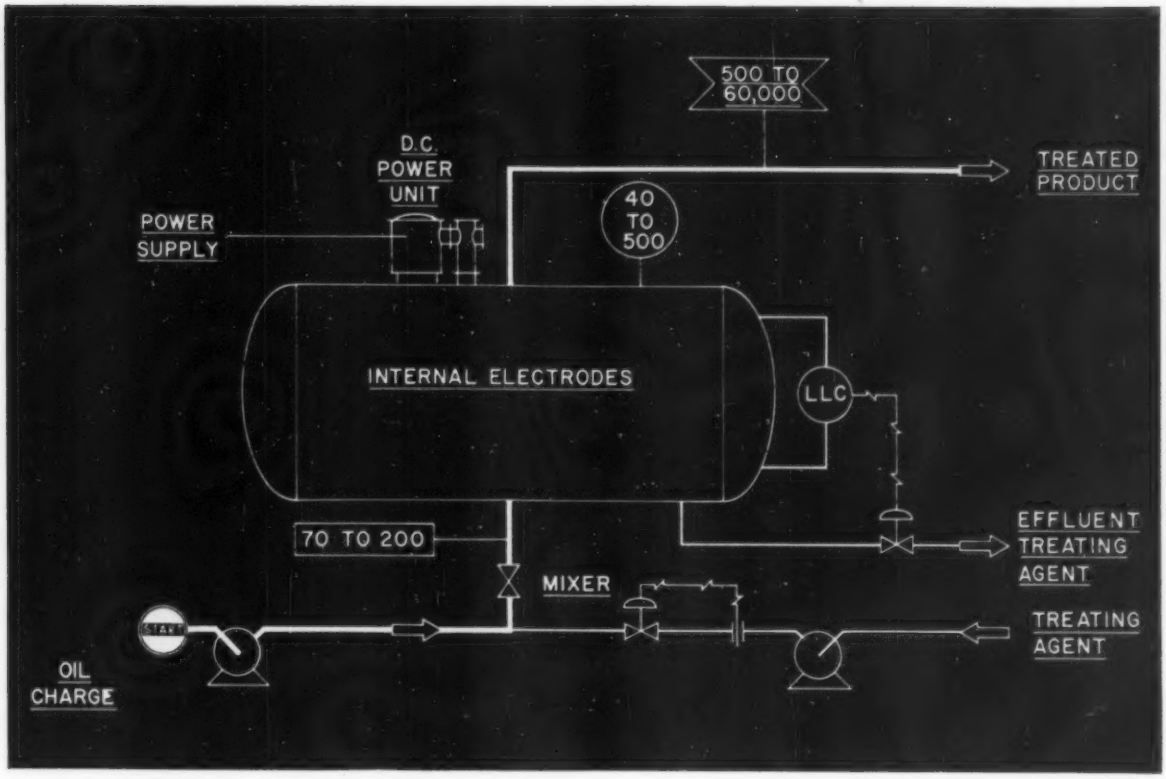
Salts in oil are most generally contained in residual water in the crude oil. Chemical composition of these salts varies widely with the major portion being sodium chlorides and less amounts of calcium and magnesium chlorides. All crude oils also contain as mechanical suspensions certain solid materials such as silt, iron oxides, silica or quartz sand crystalline salt, carbon and sulfur. Since many of these suspended impurities will be carried in or on water globules, a great proportion of them will be removed during the desalting process.

Advantages of electrical desalting include:

- Low operating costs
- Consistant operation under abnormal feedstock conditions
- High capacity
- Low residual salt levels

Operating Conditions: Depending on the characteristics of the crude being treated, temperatures required at the desalters will be in a range of 125 to 250 F. A minimum operating pressure of 40 psi is required. Higher operating pressures do not affect the process and the upper limits may be established by design requirements of other elements in the flow circuits. Several plants have been installed for operating in a range of 325 to 350 psi. Savings in installation costs may be realized by using higher pressure designs in order to eliminate surge vessels and booster pumps after the desalter.

Commercial Installations: Howe-Baker desalters now in commercial use have a design capacity of over 2.5 million barrels per day. A partial list is as follows: The Atlantic Refining Company, 82,000; California Oil Company, 65,000; Esso Standard Oil Company, 236,000; Humble Oil and Refining Company, 280,000; Imperial Oil Company, Ltd., 63,000; Lago Oil and Transport Co., 344,000; The Pure Oil Company, 104,000; Petroleos Mexicanos, 90,000; Shell Oil Company, 52,000; Socony Mobil Oil Company, 176,000; Sinclair Refining Company, 315,000; Standard Oil Company (Texas), 25,000; Sun Oil Company, 63,000; The Texas Company, 43,000; and others not listed, 466,000.



Electrical Distillate Treating—HOWE-BAKER ENGINEERS, INCORPORATED

Application: Treating of most distillates, from naphtha to lube oil boiling ranges, with treating agents such as caustic, acid or water.

Charge: Petroleum distillates.

Description: Electrical precipitations is a new means of implementing existing treating techniques with extremely high efficiency. A high voltage direct current electrical field is used to continuously break emulsions formed by treating agent and hydrocarbon. This makes possible higher mixing levels and better utilization of treating agent.

A typical example is the treatment of virgin heating oil with 15° Baumé caustic. Caustic is pumped into the heating oil stream and the two are intimately mixed. The emulsion formed goes to the treating vessel where it flows through the high voltage electrical field. The caustic is broken out of the emulsion and falls to the bottom of the vessel where it is continuously withdrawn. The treated heating oil flows out the top of the vessel directly to product storage. Sodium carryover in the oil, as NaOH, is less than 2 ppm. The oil is bright and haze-free.

Such an installation would eliminate the need for water washing, salt drying, air blowing or clay filtering steps, and would result in substantial savings. This is but one example of the infinite variety of feedstock and treating agents which can be handled.

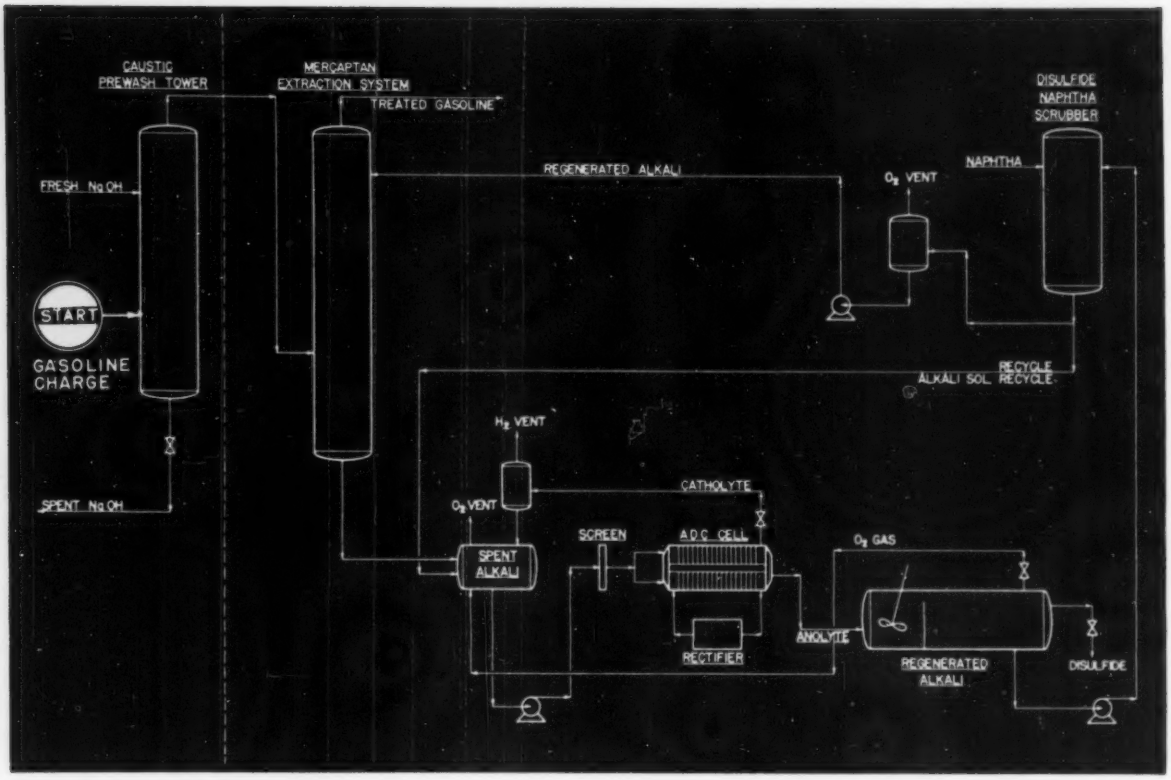
Typical treating results are shown in the table at right.

Operating Conditions: Flexibility is such that operating conditions may be varied over a wide range. Temperature normally falls in the range of 80-150 F. Very viscous stocks, such as lubes, may require higher temperatures. Operating pressure is normally in the range of 30-300 psig. Lower limit is set by vapor pressure of feedstock, and there is no upper limit except for economy of vessel cost.

Commercial Installations: Units in operation or under construction have a design capacity of over 1,500,000 barrels per day. A partial list of purchasers of these units follows: The Atlantic Refining Company, Cities Service Refining Corporation, Esso Standard Oil Company, Humble Oil & Refining Company, Mobil Oil Francaise, Socony-Vacuum Oil Company, The Carter Oil Company, Commonwealth Oil Refining Company, Lago Oil and Transport Company, and Standard Oil Company (California).

Reference: PETROLEUM REFINER, vol 34, no 9, p 194 (Sept, 1955).

Feed Stock	Treated with	Carryover
Catalytic Heater Oil	4% of 25 Be' NaOH	2.6 ppm sodium as NaOH
Catalytic Heater Oil	4% of 50 Be' NaOH	9.7 ppm sodium as NaOH
	10% Water	0.0 ppm sodium as NaOH haze-free
Virgin Heater Oil	2% of 10 Be' NaOH	1.2 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Kerosine (Paraffinic)	10% of 15 Be' NaOH	0.6 ppm sodium as NaOH
	10% Water	0.0 sodium, haze-free
Kerosine (Naphthenic)	10% of 15 Be' NaOH	0.4 ppm sodium as NaOH
	10% Water	0.0 sodium, haze-free
Light Naphtha	7% of 15 Be' NaOH	0.3 ppm sodium as NaOH
Gasoline, Straight Run	7% KOH	0.47 ppm KOH
Gasoline, Cat. and Virgin Mixture	10% of 50 Be' NaOH	7.8 ppm sodium as NaOH
Gasoline, Cat. and Virgin Mixture	10% of 30 Be' NaOH	2.9 ppm sodium as NaOH
Lube Oils:		
50 ssu @ 100 F	20 volume % H_2SO_4	0.15 volume % sludge
100 ssu @ 100 F	10 volume % H_2SO_4	0.2 volume % sludge
450 ssu @ 100 F	7 volume % H_2SO_4	0.2 volume % sludge
750 ssu @ 100 F	12 volume % H_2SO_4	0.3 volume % sludge



Electrolytic Mercaptan—AMERICAN DEVELOPMENT CORPORATION

Application: For reducing mercaptan content to improve odor and lead susceptibility.

Charge: Any hydrocarbon mixture in which the mercaptan content is objectionable.

Description: The stock, if it contains acid substances, such as H_2S and acid oils, is given a preliminary caustic wash. The pretreated gasoline is then contacted with an aqueous alkaline solution—usually NaOH or KOH—in a continuous counter-current system for mercaptan extraction. The mercaptan-rich alkaline solution flows into the spent alkali surge drum where it is mixed with partially regenerated solution and oxygen gas and then pumped to the electroyltic cell.

In the anode compartments of the cell, mercaptides are converted to disulfides with some excess of oxygen which later leaves the cell with the anolyte and is then immediately mixed in a turbo-mixer or similar device to convert additional mercaptides to disulfides. The dispersed mixture of alkali and oxygen is permitted to settle; the disulfides being substantially insoluble in the alkaline solution form an upper layer in the settler and are periodically drawn off. The regenerated caustic from the settler is given a naphtha or butane wash to remove unseparated disulfides. Part of the alkaline solution is recycled to the spent alkaline tank; the remainder is pumped to the extraction system for further service.

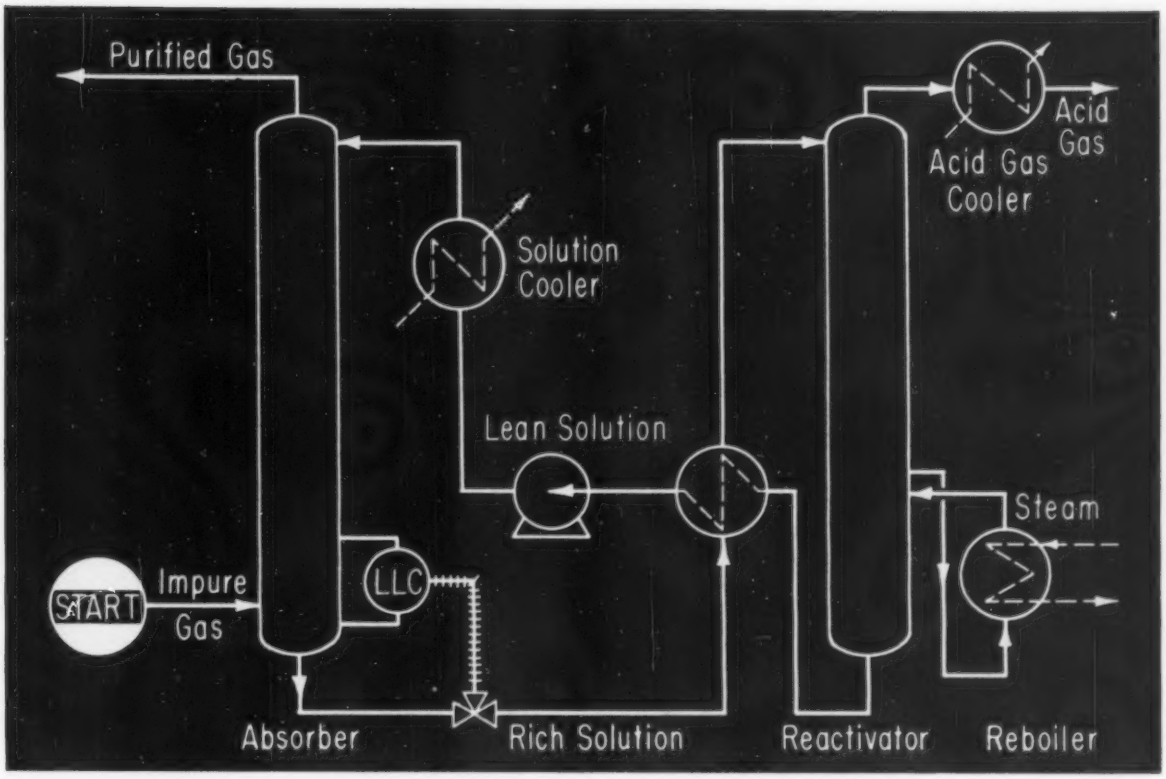
The ADC electrolytic cell is of special design with filter press plates and permeable diaphragms. The rectifier is of the conventional type.

The process normally operates at ambient temperatures and neither heating nor cooling is required. With adequate pretreatment no chemicals are consumed.

Economics: The electrolytic equipment costs between $4,000 and $5,000 per 100 pounds daily capacity for mercaptan sulfur conversion. Operating costs are relatively low—the power cost (at 1¢ kwh) for converting 500 pounds per day of mercaptan sulfur is approximately $30.

Commercial Installations: The first unit was installed at Ashland, Ky., during 1951. Capacity—5,000 bpd. Additional units have been installed at Raffineries Francaises de Petrol de L'Atlantique, Donges, France—6,500 bpd; Leonard Refineries, Alma, Mich.—5,000 bpd; Sun Oil Company, Sarnia, Ontario—2,000 bpd; Arabian American Oil Company, Ras Tanura, Saudi Arabia—25,000 bpd.

Reference: PETROLEUM REFINER, vol 33, no 11, p 205 (Nov, 1954).



Girbotol—GIRDLER CONSTRUCTION DIVISION OF CHEMETRON CORPORATION

Application: The process is employed for removal and recovery of hydrogen sulfide from natural and refinery gases, for desulfurization and dehydration of natural gas, for purification of liquid hydrocarbons, and for separation of carbon dioxide from hydrogen and synthesis gases.

Description: The Girbotol process originated with the discovery that acidic gases such as hydrogen sulfide and carbon dioxide react with certain amines to form compounds which may be broken down by heat. This reversible reaction may, in the case of hydrogen sulfide, be represented as follows:

$$RNH_2 + H_2S = RNH_2HS$$ (where R represents an organic radical)

The equilibrium proceeds to the right or left, depending on the temperature, and on the partial pressure of the hydrogen sulfide. The solutions generally employed are aqueous solutions of ethanolamines, mono-(MEA), di-(DEA) or tri-(TEA).

The operation is a continuous process in which the solution passes through the absorber where hydrogen sulfide is removed from the gas, through a heat exchanger and into the reactivator. In the reactivator hydrogen sulfide is stripped from the rich solution by heat and passes out of the tower as a concentrated gas together with some steam into the acid gas cooler. The steam is condensed in this cooler and returned to the cycle while the hydrogen sulfide may be flared, burned under a boiler or recovered as elemental sulfur.

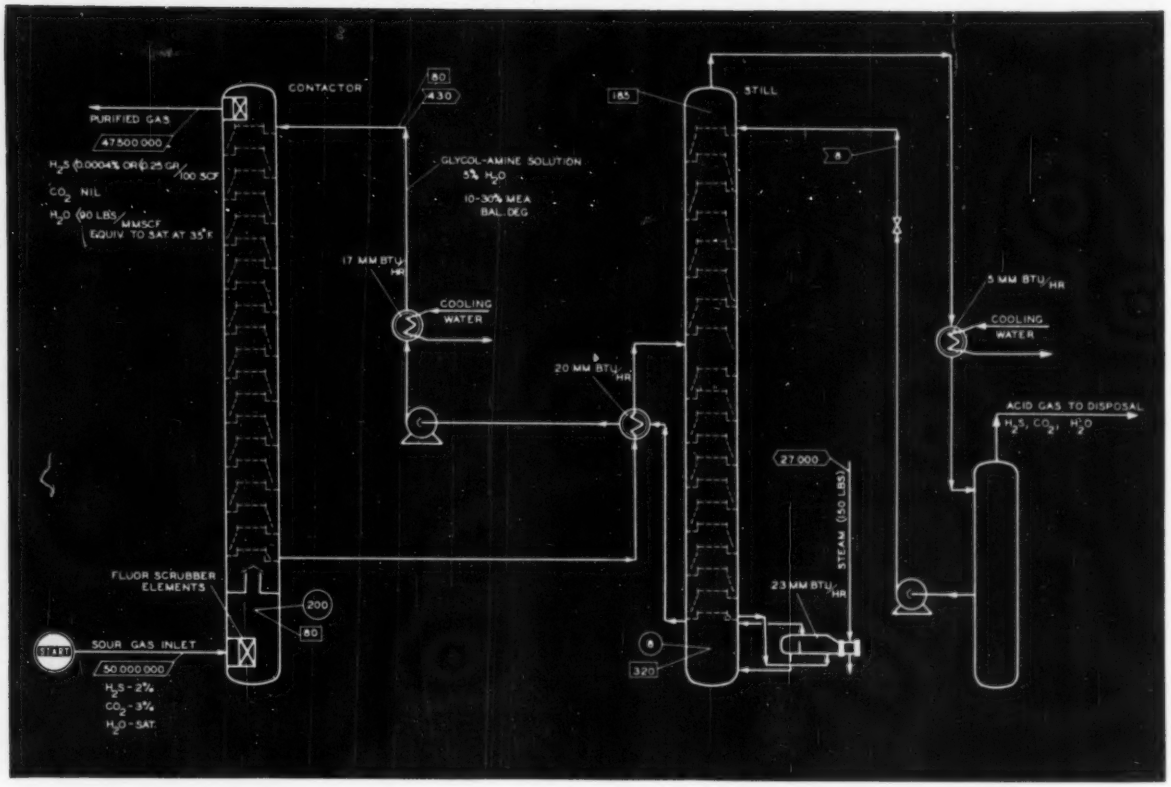
The lean solution, essentially free from acid gases, passes from the bottom of the reactivator through the other side of the heat exchanger, a circulating pump, a solution cooler and back to the absorber. The case shown is typical for high pressure natural gas operation. The absorber and reactivator towers may be either packed or bubble plate towers of conventional design.

Another type of Girbotol process is in use for purifying liquid hydrocarbons in a similar manner. A packed or sieve plate tower is used for the absorber and either the liquid hydrocarbon or the Girbotol solution maintained in a continuous phase depending on the specific case.

Operating Conditions: The choice of the proper amine and solution strength depends on the composition of the gas to be treated, the percentage of hydrogen sulfide and/or carbon dioxide in the gas and the final purity desired. In many cases it is possible to attain a moderate degree of selectivity by the proper choice of solutions and operating conditions where complete hydrogen sulfide removal is desired and carbon dioxide removal is not required. The solution circulation rate of a Girbotol plant depends on the above factors as well as on the quantity, temperature and pressure of the gas to be treated. If the gas mixture is at its hydrocarbon dewpoint, the treating temperature should be maintained 10 to 20 F. above the inlet gas temperature to prevent the condensation of hydrocarbons in the treating equipment. Girbotol plants are customarily designed to purify gases at their full line pressure and the pressure drop through the equipment ordinarily will not exceed 5 to 10 psi.

Commercial Installations: Several hundred.

Reference: *Petroleum Engineer,* vol 26, no 10, p C-57 (Sept, 1954).



Glycol-Amine Gas Treating—THE FLUOR CORPORATION, LIMITED

Application: For the continuous removal of hydrogen sulfide, carbon dioxide, and water vapor from gas streams. By the use of methyldiethanolamine, this process may be adapted to remove water and hydrogen sulfide from gas streams with selective removal of CO_2.

Product: Sour natural gas may be treated so that the residue gas will contain a guaranteed maximum of 0.15 grain of H_2S per 100 scf and be dehydrated to a degree equal to that obtainable with a straight glycol dehydrator.

Description: The process utilizes a mixture of amine (commonly monoethanolamine) and glycol (di- or triethylene glycol) in a simple regenerative cycle. As shown in the flow diagram which represents a typical application, the sour gas is introduced into the bottom of the absorbing column, the contactor. As it passes upward through the bubble trays it is thoroughly contacted with the glycol-amine solution, which enters at the top of the vessel. The outlet gas, free of the CO_2 and H_2S and dehydrated, leaves the top of this column. The rich solution containing the absorbed acid gases leaves the bottom of the contactor and passes through a bank of conventional heat exchangers, wherein the temperature of the solution is raised. The rich solution then enters the regenerating column, the still. As it flows down over the bubble trays in this column it is contacted with the rising stripping vapors, thus stripping the solution of the acidic constituents. The solution from the bottom tray of the still enters a reboiler, wherein it is boiled to provide the stripping vapor for the column. The overhead stream of acid gas and water vapor from the still passes through a condenser, and the resultant mixture is separated in an accumulator, the acid gases passing overhead from this vessel and the condensate being returned to the still as reflux. The regenerated lean glycolamine solution leaves the bottom of the still, passes through the exchangers, and is pumped back through coolers to the top of the contactor, thus completing the cycle.

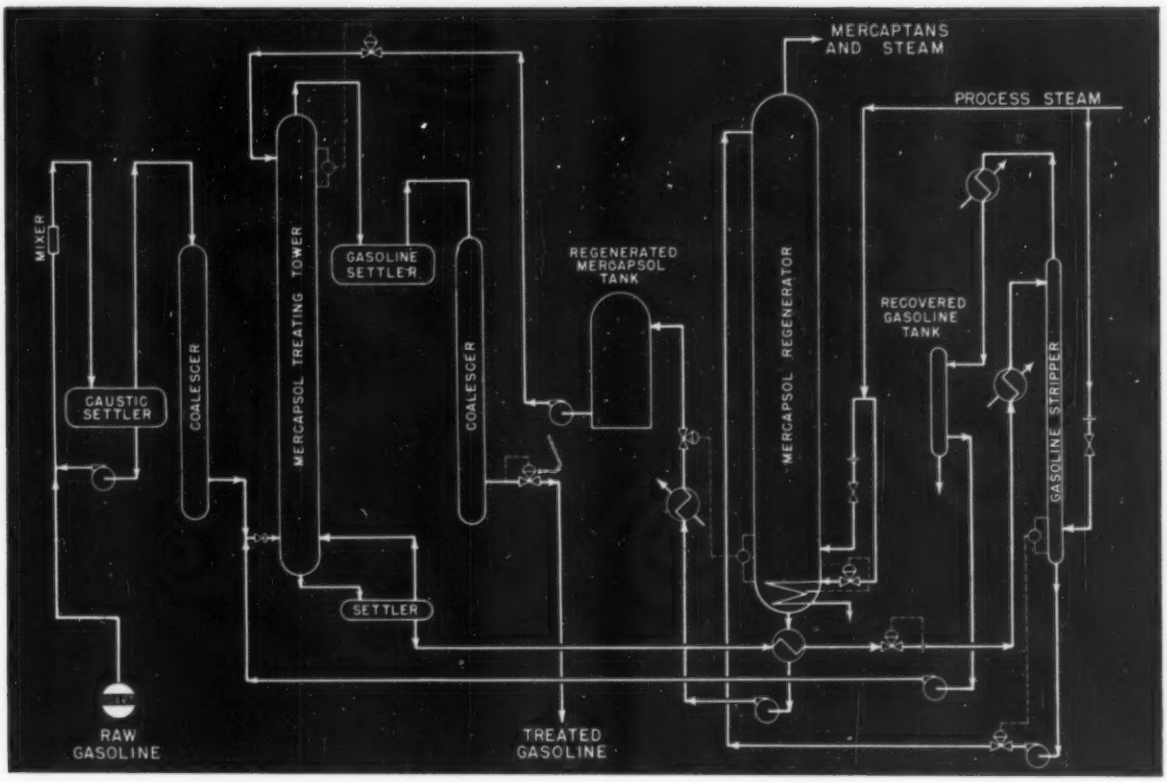
Typical solutions employed in the process may be comprised from 10 to 30 percent monoethanolamine, 45 to 85 percent diethylene glycol, and 5 to 25 percent water. The ability to adjust components of the glycol-amine-water solution makes possible a wide range of specifications for treated gas purity and water content.

Although dehydration is one primary advantage, other important advantages have resulted in the use of this process for cases where dehydration is not a prime requisite. These advantages include the ability to produce extremely high purity gas, a lower initial investment, decreased consumption of steam, and more satisfactory operation with regard to such factors as foaming and corrosion.

Yields: As a typical example, one installation in which approximately 60 Mmscf per day of gas containing 450 grains H_2S per 100 scf was treated yielded a purity of less than 0.05 grain per 100 scf.

Commercial Installations: The total installed capacity of glycol-amine plants at this time is in excess of one and one-quarter billion standard cubic feet per day.

Reference: PETROLEUM REFINER, vol 32, no 9, p 124 (Sept, 1953).



Mercapsol—THE PURE OIL COMPANY

Application: Removes mercaptan sulfur compounds from gasoline, thereby providing a method for meeting sulfur and odor specifications and for improving the lead susceptibility.

Charge: Straight run, thermally cracked or thermally reformed gasolines which are frequently very difficult to treat by other methods.

Product: In most cases a reduction in mercaptan sulfur content of 95 to 99 percent can be accomplished conveniently, and many gasolines can be extracted to doctor sweetness directly. In almost any case the use of a suitable gum inhibitor after Mercapsol treating will result in a doctor sweet product. Since mercaptans are actually removed from the gasoline instead of being converted to disulfides or other sulfur compounds, the product contains less total sulfur than the charge, and the process thus aids very materially in meeting sulfur specifications. One of the principal advantages of the process is an improvement in the tetraethyl lead susceptibility of the gasoline. An improved gum inhibitor susceptibility is an additional benefit.

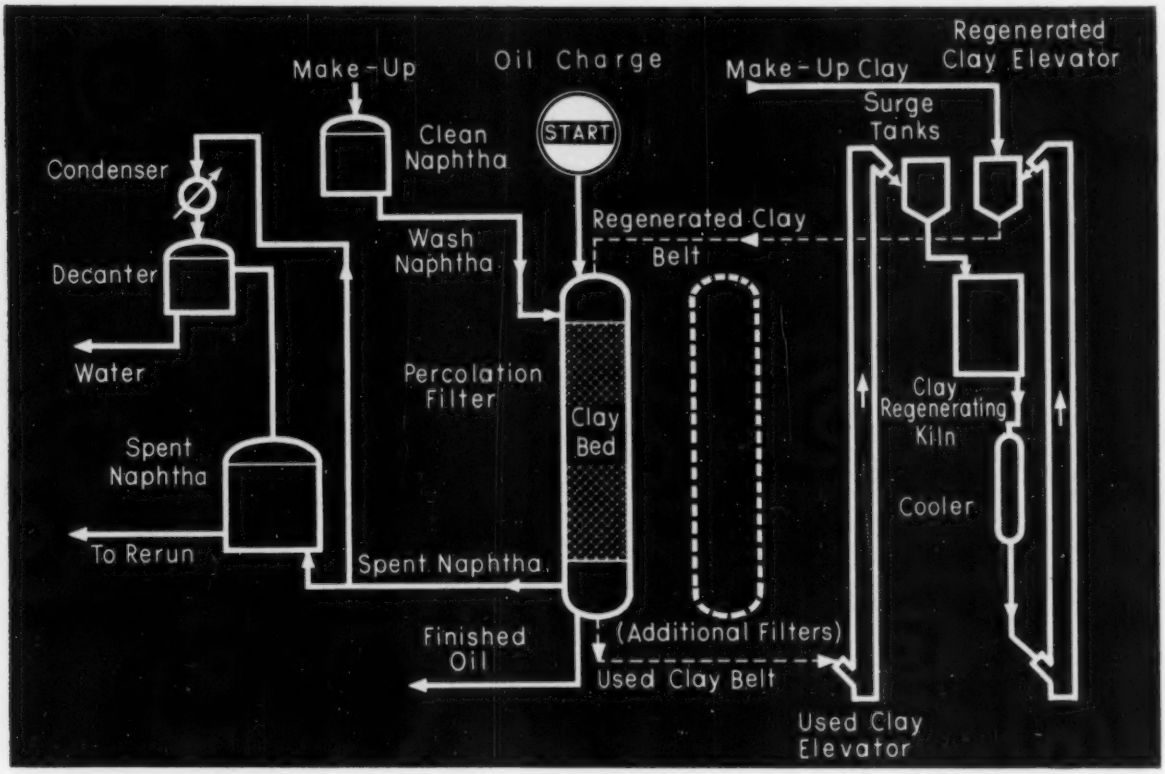
Description: The operation of the process is illustrated by the flow diagram. Gasoline is treated in the liquid phase at ambient temperatures. Hydrogen sulfide and other acidic substances, which would otherwise build up in the permanent treating solution, are first removed by contact with low strength caustic solution. The gasoline from this step passes through a coalescer whose function is to remove any aqueous phase which would contain sodium sulfide and other salts. The gasoline then enters the treating tower near the bottom, where it is intimately contacted counter-currently by the descending continuous phase of Mercapsol solution which effectively extracts the mercaptans. From the top of the treating tower the treated gasoline flows through a settler and a coalescer for clarification and on to inhibiting and storage.

Spent Mercapsol solution containing the extracted mercaptans is withdrawn from the bottom of the treating tower into a settler from which the gasoline that separates can return by density difference to the tower. The treating solution as it then flows from the Mercapsol settler contains a small amount of dissolved gasoline which is recovered and returned to the treating tower. Recovery of the dissolved gasoline is accomplished in a small stripper by the use of a small amount of steam which is sufficient for this purpose but not enough to strip much of the mercaptan present. The Mercapsol is then steam stripped of mercaptans in the regenerating tower, and after cooling is stored in the regenerated Mercapsol tank from which it is pumped to the top of the treating tower to repeat the cycle.

The Mercapsol treating solution is an aqueous solution of sodium hydroxide containing salts of certain acid oils which act as solubility promoters for mercaptans. With proper precautions against contamination and loss the solution may be used indefinitely.

Commercial Installations: Mercapsol treating has been installed in two plants of The Pure Oil Company.

Reference: *The Oil and Gas Journal,* vol 42, no 49, p 126 (Apr 13, 1944).



Percolation Filtration—MINERALS & CHEMICALS CORPORATION OF AMERICA

Application: For finish refining of lube oils and other fractions.

Product: Finished oils and waxes are characterized by excellent color, odor and taste, and by their stability in demulsifying properties.

Description: The process consists of filtering the oil or other charge through a vessel commonly containing 10 to 50 tons of adsorbent media, either fuller's earth or activated bauxite. After a preliminary period during which the clay bed is thoroughly soaked with charge oil, the latter is passed through the clay until the adsorbent fails to produce specification products. The first oil out is lightest in color. The color of the effluent oil darkens gradually as more and more oil flows through the unit. After the oil stream has stopped, naphtha is sent through the clay bed to reclaim the remaining oil. Steaming follows to recover the naphtha. The clay is then conveyed to a kiln for burning off the carbonaceous deposits of oil and impurities and returned to the filter for another cycle. The 20/60 and 30/60 mesh adsorbent grades have been found to be best adapted to most percolation refining operations.

The choice between activated bauxite and fuller's earth as the preferred percolation adsorbent is predicated on comparative costs and product quality considerations. In many cases the same high product quality is possible with either adorbent and the choice may rest solely on any difference in capital investment or on operating costs.

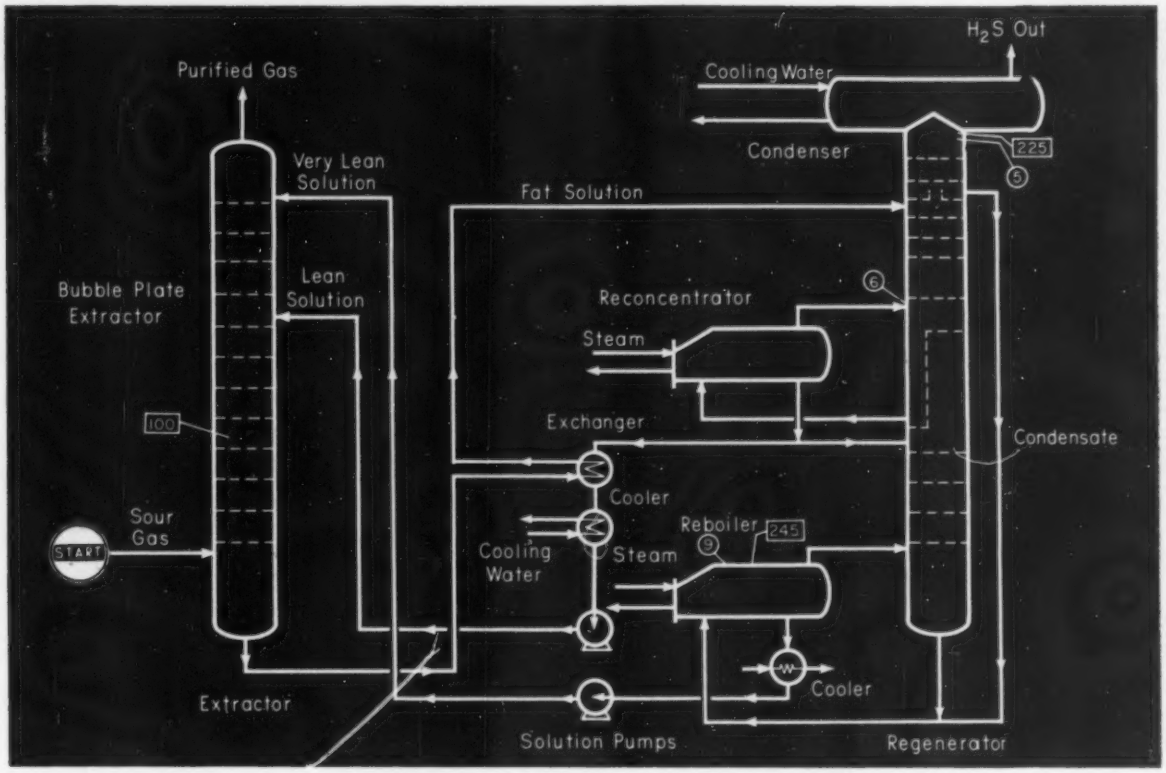
Yields: See table. The relative yields will vary with different oils, the principal factors influencing them being crude oil source and the amount of refining pre-treatment lubricating oil fractions received prior to filter finishing. Generally heavy decolorization requirements will favor fuller's earth while lighter color loads (less color reduction) will favor bauxite.

Commercial Installation: More than 53 installations.

References: *Petroleum Processing*, vol 2, no 9, p 673 (Sept, 1947).

CRUDE SOURCE	PROCESSING (A)	(B)	(C)	UNFILTERED OIL INSPECTION API Gr.	Viscosity-S.U. 100 F.	210 F.	Viscosity Index	Pour Point °F.	Color NPA	PERCOLATION YIELD New Fuller's Earth Bbl./Ton	Bbl./MCF	New Bauxite Bbl./Ton	Bbl./MCF	Color NPA
North Louisiana	....	P	MEK	28.0	207.0	46.5	92	—10	2—	77	1280	48	1360	1½
West Texas	....	D	MEK	32.7	208.8	47.4	103	— 5	1¼	257	4270	151	4270	1
Cal-Waxy	....	P	P	28.9	325.7	51.5	76	— 5	4 dil	84	1395	65	1840	2
Iraq	....	F	MEK	28.1	457.0	60.8	95	0	7¼	160	2650	130	3690	3
Oklahoma	....	F	MEK	29.1	511.6	62.6	90	0	4¼	52	865	114	3230	2
Ease Texas	Yes	D	MEK	27.7	1115.7	92.4	93	0	8	25	415	23	642	4
East Texas	Yes	P	MEK	27.4	1678.2	117.3	94	5	5¼	52	865	47	1330	5
West Texas	Yes	D	MEK	26.6	1618.3	119.3	99	5	7—	63	1045	60	1700	6

(A) Propane deasphalting. (B) Solvent extraction—P = Phenol, F = Furfural, D = Duosol. (C) Dewaxing—MEK = Methylethylketone—benzol, P = Propane.



Phosphate Desulfurization—SHELL DEVELOPMENT COMPANY

Application: For removing and recovering hydrogen sulfide from natural and refinery gases and liquid hydrocarbon fractions. The process consists of two steps: absorption and regeneration.

Description: The principal absorption reaction may be expressed by the equation:

$$K_3PO_4 + H_2S = K_2HPO_4 + KHS$$

Regeneration of the solution is effected by means of stripping steam, which reverses the absorption reaction.

Treatment of gas and liquid streams differs only in the design of the extractor and, generally, in the use of split-solution flow for gas treating. The sketch shows the split-solution flow scheme.

Under actual operating conditions the tripotassium phosphate solution used in the process removes H_2S preferentially from gases containing both H_2S and CO_2. This unique feature of the Phosphate Process may be highly advantageous in desulfurization of natural or synthesis gases. In such cases it is often unnecessary or undesirable to remove most of the CO_2 along with H_2S for reasons besides the higher attendant stripping steam consumption.

The Phosphate process is particularly suitable for recovery of H_2S from which it is desired to make elemental sulfur. For that purpose it is important that the recovered H_2S be of high purity, i.e., with minimum CO_2 and hydrocarbon content. The Phosphate process can remove H_2S economically from gases containing CO_2 and H_2S in ratios as high as 20 to 1.

In treating gases, the extraction step is carried out in a bubble-tray column using split-solution flow. The raw gas is contacted countercurrently with the lean solution in the lower section of the column for removal of the bulk of the H_2S; as it proceeds through the upper part of the column, the gas is further contacted with the very lean solution to achieve the final degree of H_2S removal required.

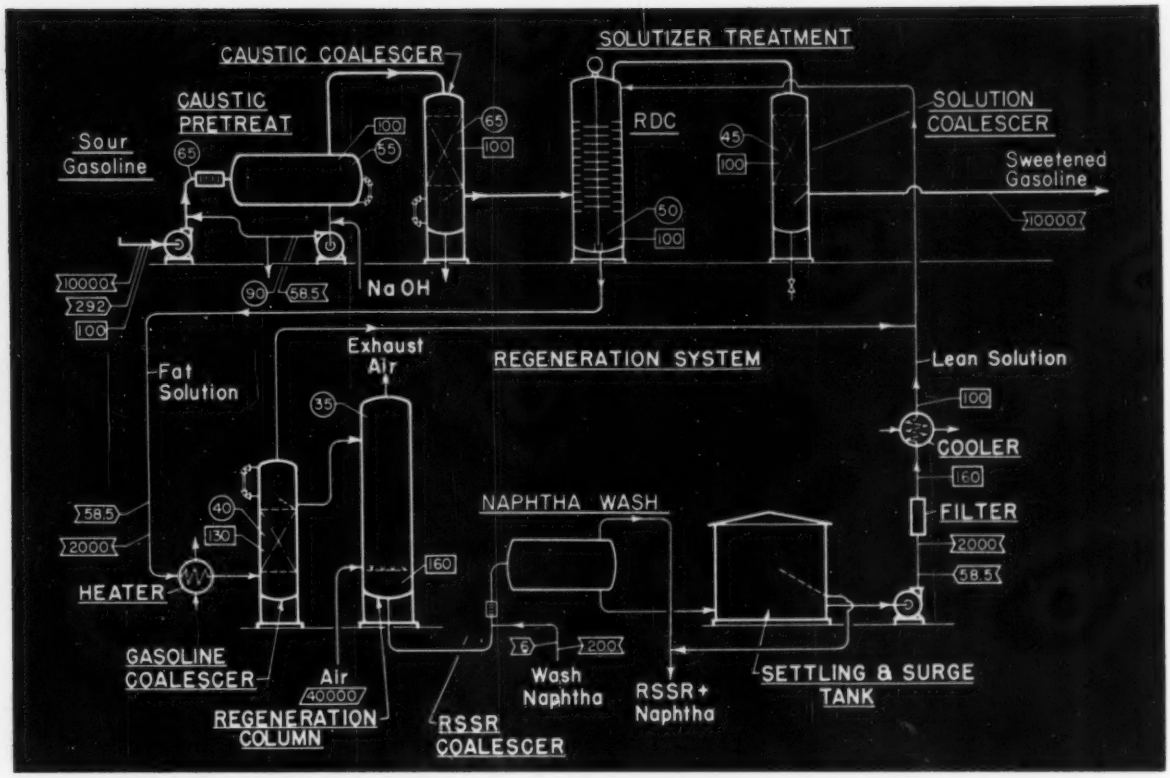
In the treatment of liquid hydrocarbon streams, the extraction step is achieved with countercurrent single-solution flow. After extraction, the liquid hydrocarbon flows through a solution coalescer which serves to safeguard against solution loss through entrainment.

The hydrogen sulfide recovered by this process is essentially free of hydrocarbons and is an ideal raw material for manufacture of sulfuric acid or elemental sulfur.

Since K_3PO_4 is a stable inorganic salt which does not decompose nor vaporize under treating conditions, it does not contaminate nor polymerize the hydrocarbons and the solution loss is negligible. Iron and steel are satisfactory for all equipment. If the cooling water is corrosive, admiralty-metal tubes and Muntz metal sheets and baffles may be used in the condenser and solution coolers. Gages, instruments, valves, and pumps should be all iron and steel. Observance of these general specifications will insure freedom from corrosion on the process side.

Commercial Installations: Forty plants have been installed.

Reference: PETROLEUM REFINER, vol 18, no 8, p 334 (Aug, 1939).



Solutizer Process—SHELL DEVELOPMENT COMPANY

Application: For removing mercaptans from sour gasolines.

Product: Mercaptan removal to the "odor sweet" level of 0.001 to 0.003 weight percent mercaptan sulfur is easily achieved when treating a wide range of straight-run or cracked stocks, either low-end-point or full-boiling-range gasolines.

Description: The three essential steps of the process are caustic pretreatment, solutizer treatment, and regeneration. Caustic pretreatment is often necessary to remove acidic component such as hydrogen sulfide and, in some cases, to control the alkyl phenol concentration. A single conventional mixer-settler arrangement is usually satisfactory for this purpose, and the caustic solution may be used until it is essentially saturated. A coalescer follows the caustic settler to minimize contamination of the potassium hydroxide treating solution with sodium ion.

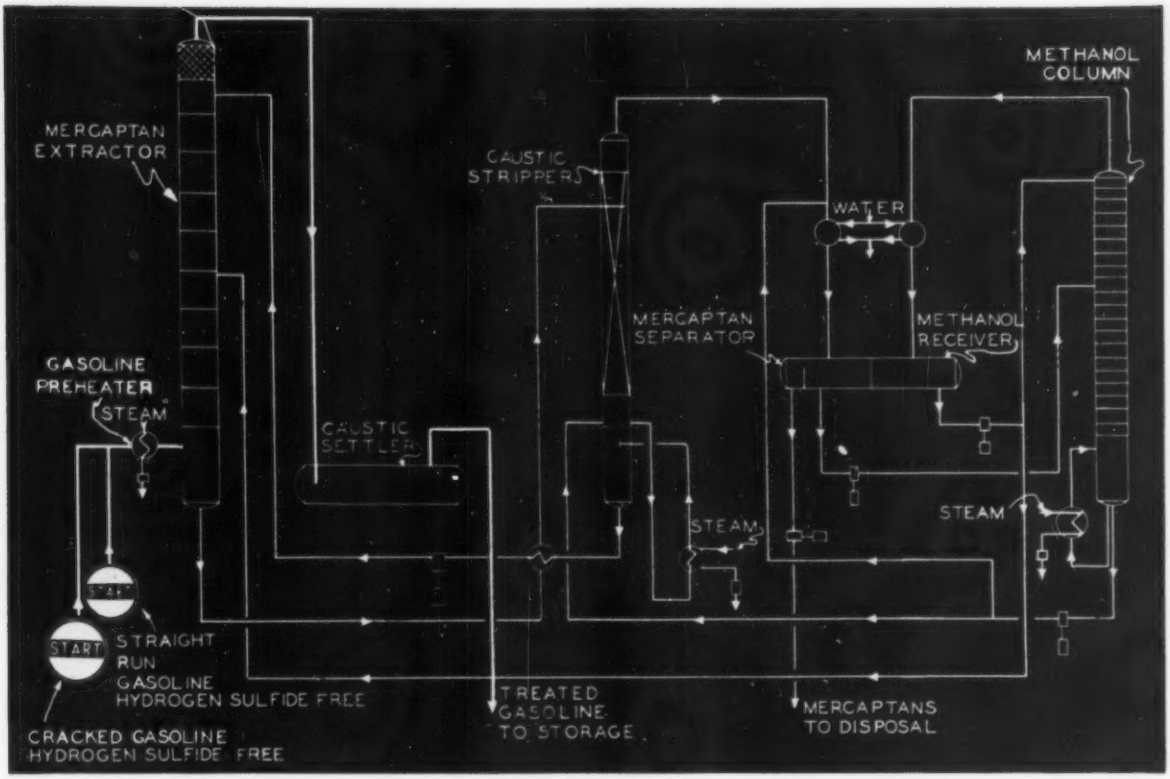
For mercaptan extraction the sour hydrocarbon feed is contacted with a suitable solutizer solution in countercurrent flow. The extracting agent is strong potassium hydroxide solution containing mercaptan solubility promoters (solutizers) such as fatty acids; e.g., propionic and butyric acids, and/or alkyl phenols. The latter may be used if their concentration in the fraction treated is great enough to maintain the required solutizer strength in the treating solution.

In the past, mixer-settler units have been used for the mercaptan extraction step. However, in all new designs, the Shell Rotating Disc Contactor (RDC) has replaced mixer-settlers. Use of the new apparatus in this step of the process substantially reduces capital cost and adds significantly to operating flexibility.

The treated hydrocarbon flows from the extraction section to storage or subsequent operations. The spent treating solution is heated to 130 to 160 F., passes through a gasoline coalescer, and enters the regenerator where the extracted mercaptans are oxidized to disulfides by air blowing. This operation is accomplished in a column equipped with efficient air dispersers or in any standard liquid-gas mixing device. Dissolved and/or entrained disulfide oil is removed by a naphtha wash. The naphtha required is only 1 to 2 percent of the gasoline treating rate, and it may be disposed of by adding it to reforming or catalytic cracking charge stock. The regenerated solutizer solution is then cooled and returned to the extraction step.

No corrosion-resistant metals are required since operating temperatures are low and the treating solution is noncorrosive. Labor costs are low due to the simplicity of operation and adaptability to virtually complete automatic control. The solution is inexpensive and has an extended treating life, so that chemical cost is nominal. Exhaust steam can be used to fulfill the limited heating requirements.

Reference: PETROLEUM REFINER, vol. 18, no 5, p 171 (May, 1939).



Unisol Mercaptan Extraction—UNIVERSAL OIL PRODUCTS COMPANY

Application: Extracts mercaptan sulfur compounds and certain nitrogen compounds from gasoline and higher boiling petroleum fractions.

Product: The mercaptan content of the treated product can be controlled to any level desired—from 95 percent to complete removal (Doctor sweet). If complete removal is not economically desirable, the product may be made Doctor sweet by short-time storage in the presence of an inhibitor. Octane number improvements at the 3 cc tetraethyl lead level range from one to three or more points, depending on the mercaptan sulfur content of the untreated gasoline.

In comparisons of the properties of Unisol treated gasoline with the raw gasoline or with the product obtained by conventional sweetening, it is generally found that Unisol treating improves inhibitor susceptibility and lowers ASTM gum, and that copper-dish gums, after inhibiting, are considerably lower.

Modifications not shown in the flow diagram above enable the process to remove 95 percent or more of the mercaptans from distillates such as kerosine and domestic heating oil, thereby producing oils with superior odor characteristics. Pyrrole nitrogen compounds, which are detrimental to fuel oil stability, also are removed by the process. Filter and burner tip plugging tendencies of domestic fuel blends of virgin and catalytically cracked cycle stocks are greatly reduced by Unisol treating.

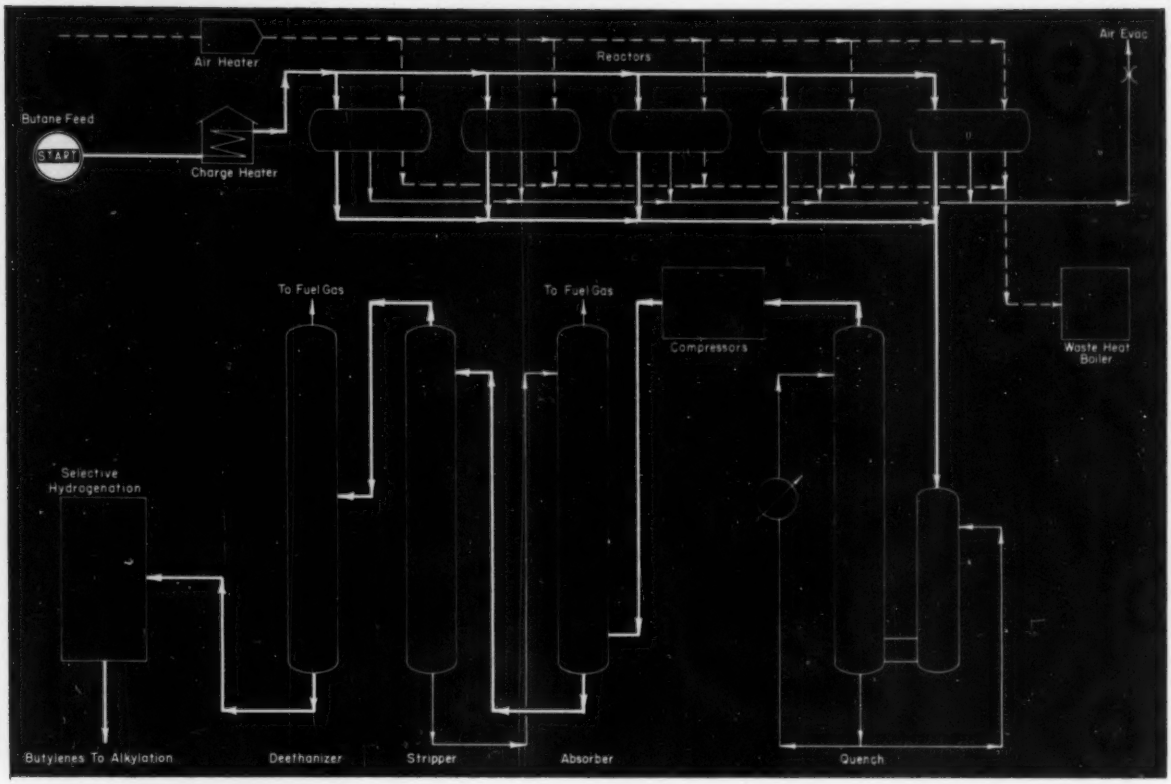
Description: Hydrogen sulfide-free gasoline is charged to the bottom of an extraction column where it meets in countercurrent flow an aqueous solution of methanol and caustic soda. The caustic solution is introduced near the top of the extractor and the methanol enters near the mid-point. The caustic soda is introduced separately, above the methanol inlet, in order to recover any methanol dissolved in the gasoline.

Treated gasoline is recovered as an overhead product, and receives no subsequent treatment except addition of inhibitor. The mercaptan-rich caustic-methanol solution is withdrawn from the bottom of the extraction column and charged near the top of the caustic stripper. Here mercaptans, water and methanol are taken overhead, leaving the caustic solution as a bottom product ready for re-use.

Removal of the alcohol greatly simplifies complete stripping of the mercaptans from the caustic solution, resulting in great operating economy.

The mercaptan-rich methanol is diluted with water, cooled and collected in a separator from which the mercaptans are decanted as an oily supernatant layer for disposal. The aqueous methanol solution then is transferred to a fractionator which recovers nearly anhydrous methanol as an overhead product for return to the process, and a water bottom product. The water is charged to the caustic stripper, where it evaporates to form stripping steam. No water is withdrawn from the system.

Reference: *The Oil and Gas Journal*, vol 47, no 19, p 95 (Sept 9, 1948).



Butane Dehydrogenation—HOUDRY PROCESS CORPORATION

Application: For alkylation feed preparation.

Charge: Normal butane.

Product: Butylenes for alkylation feed or by modification butadiene for petrochemicals production.

Description: The Houdry Dehydrogenation Process is an adiabatic fixed bed catalytic process that may be operated selectively to produce mono and diolefins either separately or concurrently.

In a typical operation for butylenes only from normal butane charge, the feed is preheated to reaction temperature prior to contact with catalyst in the horizontal fixed bed reactor. Hot effluent from the reactors is cooled in a quench tower by direct contact with circulating oil, then passes to a compression cooling system. Uncondensed gases go to an absorber and stripper for recovery of C_4 and heavier material. Stripper effluent and condensed liquids are stabilized and selectively hydrogenated to remove diolefins. The product of these operations is a high quality alkylation feed stock.

Power-operated valves are controlled by a special cycle timer which programs the reaction, purging, and regeneration sequences. Hydrocarbons are purged from the on stream reactor prior to regeneration, and combustion gases are purged after regeneration.

This process employs catalysts in the form of cylindrical pellets consisting of active alumina impregnated with 18 to 20% chromic oxide. Catalyst is regenerated in the reactors by burning off the coke deposit with preheated air.

Inert granular material of high heat capacity may be mixed with the active catalyst in predetermined amounts, to obtain the desired heat capacity of the catalyst bed.

Operating Conditions: In this cyclic process the operating conditions are chosen to give essentially adiabatic operation with the heat required for reaction during the onstream period substantially the same as that supplied by combustion of coke deposit during catalyst regeneration. The major process conditions normally will be within the following ranges:

Temperature—1,000 to 1,200 F.
Pressure—5 inches Hg absolute or higher
Space Rate—1 to 3 vol. charge/vol catalyst/hr
On stream Period—7 to 15 minutes

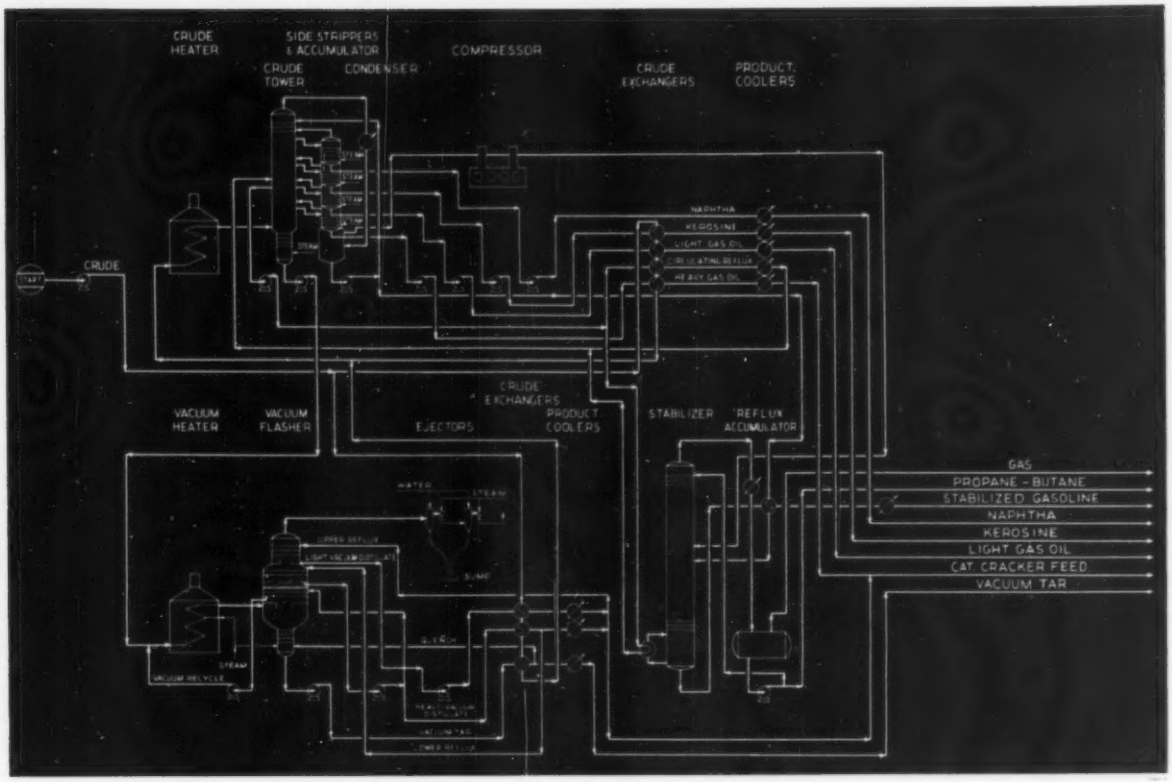
Yields: When making butylenes for alkylation feed, ultimate yields of olefin from butane are 83.7 wt. % as shown in the following tables. A low coke yield, less than 2.0 wt. % of converted material further demonstrates the selectivity and efficiency of the operation.

References: PETROLEUM REFINER, vol 33, no 12, p 173 (Dec, 1954).

TYPICAL ONCE-THROUGH YIELDS FOR BUTYLENE PRODUCTION

	Total Reactor Feed, Weight Percent	Alkylation Feed Stock After Selective Hydrogenation, Weight Percent Reactor Feed
Dry Gas (Iincluding H_2)	....	5.7
Propane	....	1.2
Propylene	....	2.7
iso Butane	1.0	.7
iso Butylene	....	.6
n Butane	99.0	50.0
n Butylenes	....	37.9
C_5+	....	.3
Total	100.0	99.1(1)

(1) Coke deposit on dehydrogenation reactor catalyst of 0.9 weight percent of hydrocarbon feed not included, as product.



Crude Distillation for Maximum Cracking Feed—

STONE & WEBSTER ENGINEERING CORPORATION

Application: To obtain maximum catalytic cracker feed by distillation of crude oil.

Products: The products shown are typical of a combination atmospheric and vacuum distillation unit. Catalytic cracker feed consists of atmospheric heavy gas oil augmented by light and heavy vacuum distillates.

Description: Crude oil is preheated by exchange with product and reflux streams before passing through a fired heater to the crude tower. The exchanger arrangement is selected on the basis of distillate draw-off temperatures and fuel value to give maximum economical heat recovery.

Initial fractionation of the crude oil takes place at essentially atmospheric pressure to produce the overhead and the four side streams shown. The overhead passes to a condenser and the net light gasoline product is charged to a stabilizer for vapor pressure control. Uncondensed gas is compressed and flows to the stabilizer for recovery and fractionation. Alternatively, the stabilizer might be integrated with the catalytic cracker gas recovery unit.

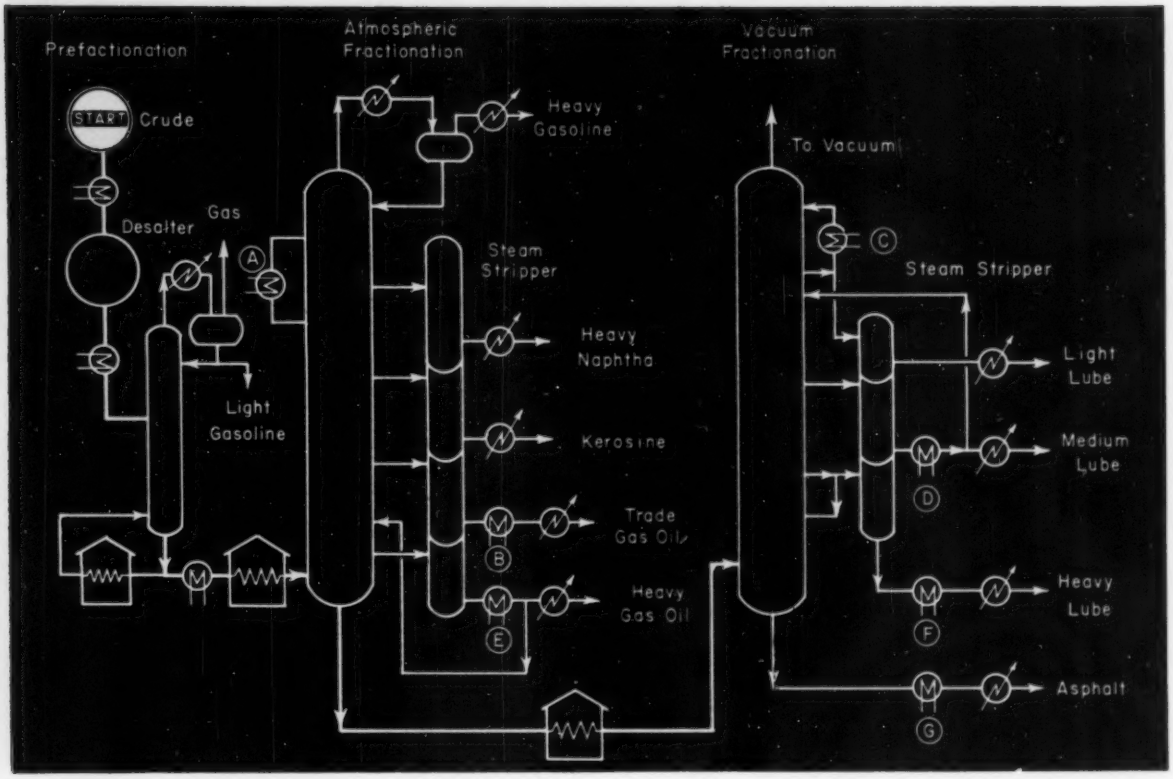
In order to obtain maximum yield of gas oil suitable for catalytic cracker feed, the bottoms from the crude tower is further heated and vaporized in the vacuum flasher. Steam is used to assist vaporization and avoid excessive temperatures which would cause undesirable cracking of the residue. The selection of the optimum operating pressure in the vacuum flasher is influenced by a number of factors, including maximum permissible flash temperature, steam to hydrocarbon ratio and temperature of cooling water for the vacuum condensers or barometrics.

Vacuum distillate is condensed within the tower and withdrawn as two side streams to improve the heat recovery. Both atmospheric and vacuum towers are equipped with circulating reflux systems for heat removal. This arrangement reduces top reflux and tower size, and provides high level heat for crude exchange and reboiler service.

The production of a catalytic cracker feed with minimum carbon residue and metal contaminants is of great importance. Carbon residue can cause excessive coke formation while metal contaminants seriously affect catalyst selectivity and product yield distribution. Provisions for minimizing entrainment in the vacuum tower are therefore imperative. In the unit shown, entrainment is minimized by the use of wash trays and wire mesh located above the vaporizer. Wire mesh may also be used in the atmospheric tower to improve heavy gas oil quality.

Liquid from the bottom wash tray is pumped back into the feed entering the heater. A continuous flow of oil over the trays below the heavy vacuum distillate is thereby assured, without diluting the vacuum residue.

Vacuum tar is stream stripped and pumped through heat exchangers to storage. This product may be cut-back with a catalytic cycle stock or other low quality distillate for use as refinery fuel. A portion of the cooled tar is returned to the base of the tower to reduce the temperature and prevent coking of the residue.



Crude Distillation for Maximum Lubes—FOSTER WHEELER CORPORATION

Application: The process is applied to the fractional separation of crude oil while producing a maximum yield of lubricating oil stocks.

Description: A simplified flow diagram of the process is shown. The crude picks up heat from some of the other streams within the system by passing through exchangers represented by letters in the flow diagram. The crude flow is first through the reflux recirculating system (A) and is then split into two streams. One stream picks up further heat through heat exchange with the trade gas oil fraction (B) from the atmospheric tower and this preheated stream then moves on to the electrolytic desalter. The other portion of the stream acquires additional heat through heat exchange in the light vacuum gas oil reflux circulating system (C) and it too enters the electrolytic desalting system.

Leaving the desalter, the preheated crude is further increased in temperature by heat exchange in the reflux recirculating system (D). It then passes directly to the prefractionator where water and light gasoline and noncondensable gas are flashed off.

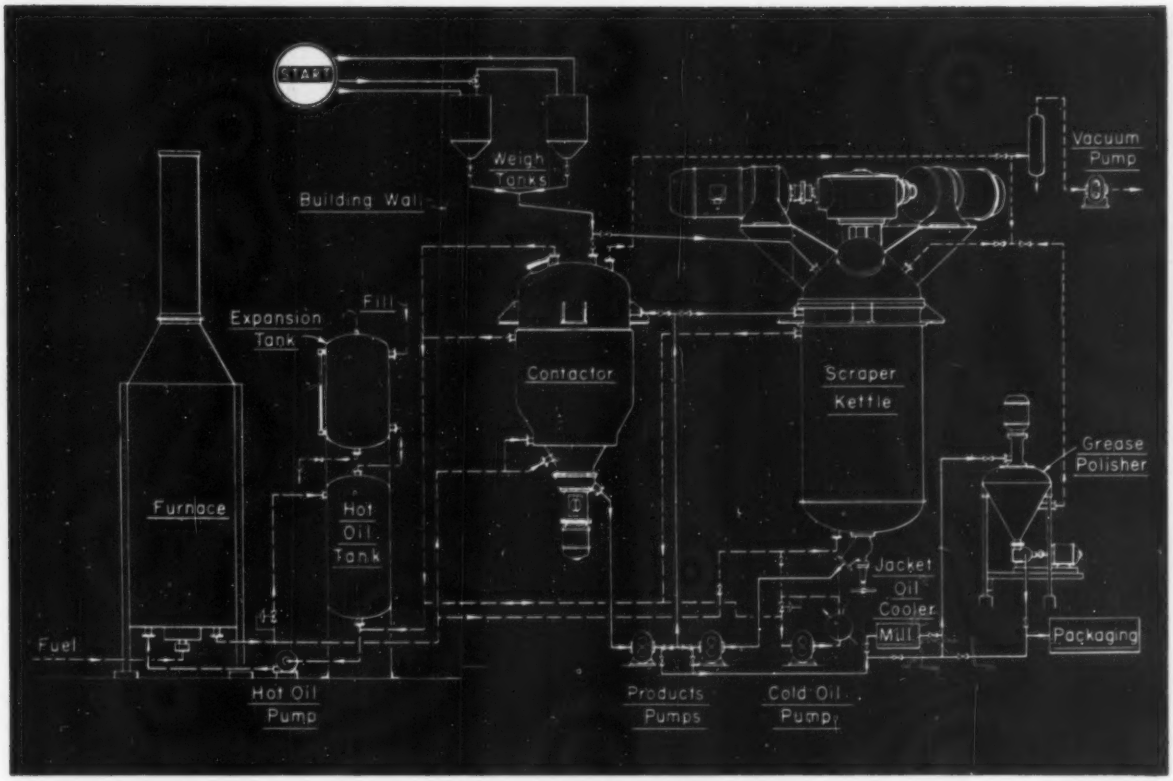
The partially reduced crude is pumped from the prefractionator and this stream is also split into two parts. A small stream passes through a direct-fired heater and re-enters the prefractionator to maintain a desired temperature in the prefractionator. The major portion of the stream leaving the prefractionator exchanges heat in the recirculating reflux system (E). It then passes through recirculating reflux system (F) picking up more heat and finally obtains its last preheat by passing through an exchanger through which the hot asphaltic bottoms from the vacuum unit are being pumped (G).

The partially reduced crude, now preheated to a temperature of 420 F., enters a direct-fired atmospheric heater in which it is raised in temperature for the purpose of vaporizing the products required from the atmospheric fractionating column. The mixture of reduced crude and vaporized lighter products then passes directly to the atmospheric column where the fractionation into the desired products takes place.

Four sidestream products are removed from the atmospheric column and enter the stripping tower where they are flashed to specification quality. The vapor stripped-off by open steam returns to the column. The stripped sidestreams are cooled and pumped to storage.

The reduced crude from the bottom of the atmospheric column is pumped directly to the direct-fired vacuum heater in which it is raised in temperature to effect vaporization of all but an asphaltic residue. This mixture of vapor and asphalt then passes into the vacuum fractionating column for the purpose of separating the mixture into desired intermediate products.

Three lubricating distillate sidestreams and a residue are drawn from the vacuum column and are pumped through coolers to storage for subsequent processing. The asphalt residue is pumped from the bottom of the vacuum fractionating column.



Grease Manufacturing—STRATFORD ENGINEERING CORPORATION

Application: For the manufacture of a wide range of lubricating grease.

Charge: Various compounds of fatty acids and alkali earth metals to form a soap, together with petroleum oils or other materials.

Products: Lubricating grease such as calcium, soda, lithium, barium, aluminum, mixed-base and non-soap base grease of desired specifications.

Description: The process involves accurate weight control of all feed components, intimate mixing, rapid heating and cooling, together with milling, dehydration and deaeration, whenever required. The major process equipment consists of an oil circulation heater, high dispersion contactor, scraper kettle and a grease polisher.

The soap is prepared by charging weighed quantities of ingredients to the contactor. The reaction is conducted at uniform temperature through the circulation of a hot oil through the shell and circulation tube jackets of the contactor. Time cycles of only 30 minutes are required to complete the saponification reaction and excess water may be removed simultaneously through a vacuum line, if desired. The remainder of the oil and additives may then be charged into the contactor to complete the manufacture of the grease, or the soap may be transferred into a scraper kettle where these ingredients are added and the grease is finished to specification. The heavier types of grease are normally finished in the scraper kettle due to the high viscosity which prevails at finishing temperatures.

The hot oil circulation pump provides 400F. to 600F. hot oil to the jackets on the heating cycle. On the cooling cycle the cold oil jacket pump is employed recycling jacket oil through the cooler.

The finished grease from either the contactor or scraper kettle may be packaged directly or further processed in a grease mill and grease polisher, as required by the specifications of the final poduct. A typical time cycle required for the manufacture of calcium type grease is 1½ to 2 hours, and for soda base grease, approximately 2 to 3 hours.

Pilot size equipment is normally used in conjunction with the commercial equipment for the purpose of plant guidance and the development of new and improved grease formulations.

Commercial Installation: Many installations of the described type have been in operation for a number of years, both in this country and abroad.

Light Hydrocarbon Recovery Processes

Application: Refinery gas recovery and gasoline stabilization. The initial refinery application, the setting of gasoline vapor pressure in fractionating column stabilizers, continues to be a major refinery process operation though vapor recovery and fractionation units are now among the essential secondary refinery processes.

Practically all refineries in operation today include some form of gas-recovery and fractionation plant. Their design depends upon the type of refinery process units employed and the amounts of wet gas and unstable distillates to be handled. Each refinery situation requires special consideration.

Charge: Unstable distillates and wet gas streams from refinery processing unit such as cracking plant fractionator, catalytic reforming unit, coking unit and hydrogen-treating unit.

Products: Gasoline, butanes-butylenes, propane-propylene, residual gas.

Description: Recovery unit designs vary according to feed stream composition and desired recovery of light ends. As noted above, the feedstock can be derived from several sources, and in such case considerable flexibility must be provided. The *absorption-fractionation* method is well-adapted to feedstock variations and is most frequently used. An alternate method is *straight-fractionation* at reduced temperature. A third method, *selective adsorption,* has been proposed but not shown to be economically feasible in gas plant service.

In general, 70-90 percent of the propane in the feedstock is recovered, with ethane and lighter materials being rejected completely. This rejected stream, containing inerts, hydrogen, methane, ethylene, ethane, propylene and propane, is a valuable raw material for petrochemical manufacture. Methods for separating and utilizing it are given in the Petrochemical Handbook (PETROLEUM REFINER, November, 1957).

Absorption-fractionation recovery facilities are represented in the upper flow diagram on the opposite page. The feed stream, consisting of both gas and liquid, is charged to a fractionating absorber wherein propane and heavier hydrocarbons are absorbed in a stabilized gasoline fraction. Stripping action in this column serves to reject ethane unavoidably absorbed at the feed tray conditions. Overhead vapors from the fractionating absorber may be scrubbed with a heavier oil to recover light absorption oil carried upward from the top tray.

Rich oil from the absorber passes to a stripping column (debutanizer) wherein C_3 and C_4 fractions are removed overhead. A portion of the stripped oil is recirculated to the absorber, and the remainder is withdrawn and further fractionated, if desirable, to light and heavy cracked gasoline fractions.

The debutanizer overhead product passes to the depropanizer wherein a separation is made between a propylene-propane fraction and a butane-butylene fraction. The former fraction serves as poly-gasoline feedstock and contains no more butanes than allowed by propane LPG specifications after the propylene is converted to gasoline. The butane-butylene fraction serves as alkylation plant feedstock, and has similar limitations on propane content.

Straight fractionation recovery facilities are represented by the typical flow diagram on the lower part of the opposite page. In the case shown, the feed stream consists of gas from a treating unit, plus gas and gasoline from a cracking plant.

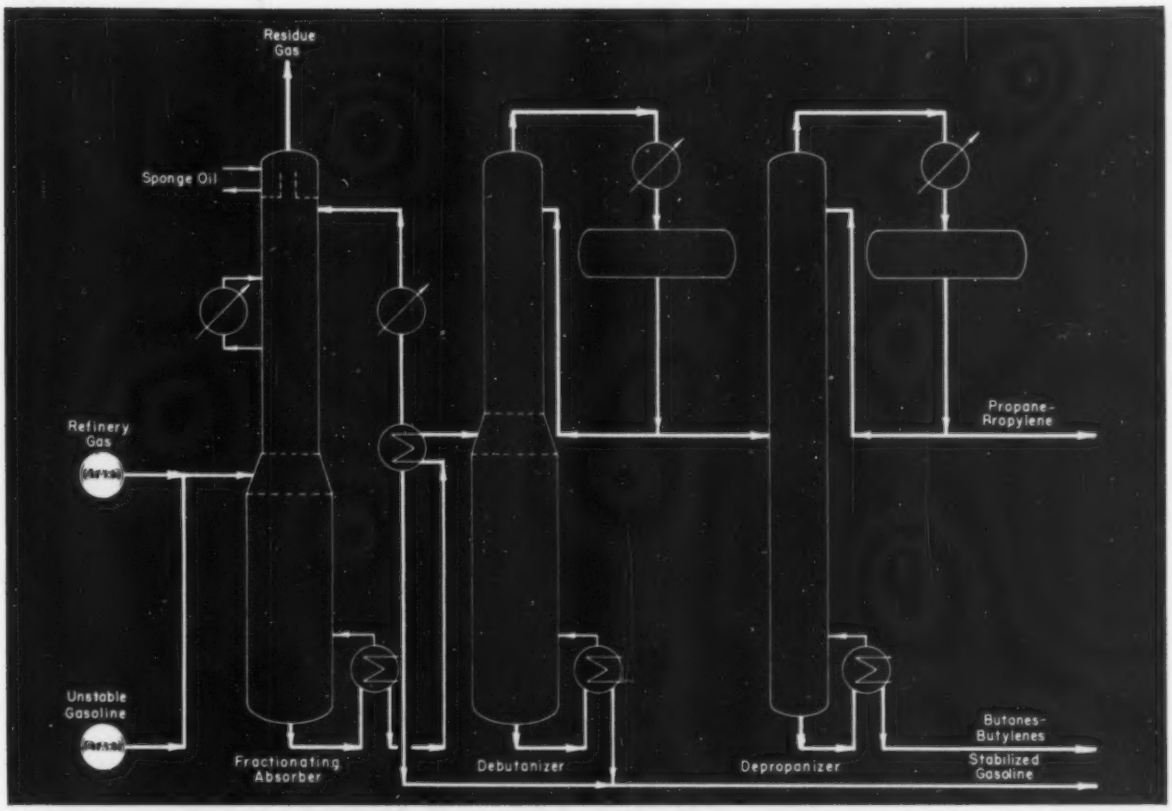
Motor gasoline from the cracking plant is charged to the debutanizer. This column is operated at 185 psig to effect recovery of the major portion of the overhead as liquid. Debutanized gasoline goes to storage.

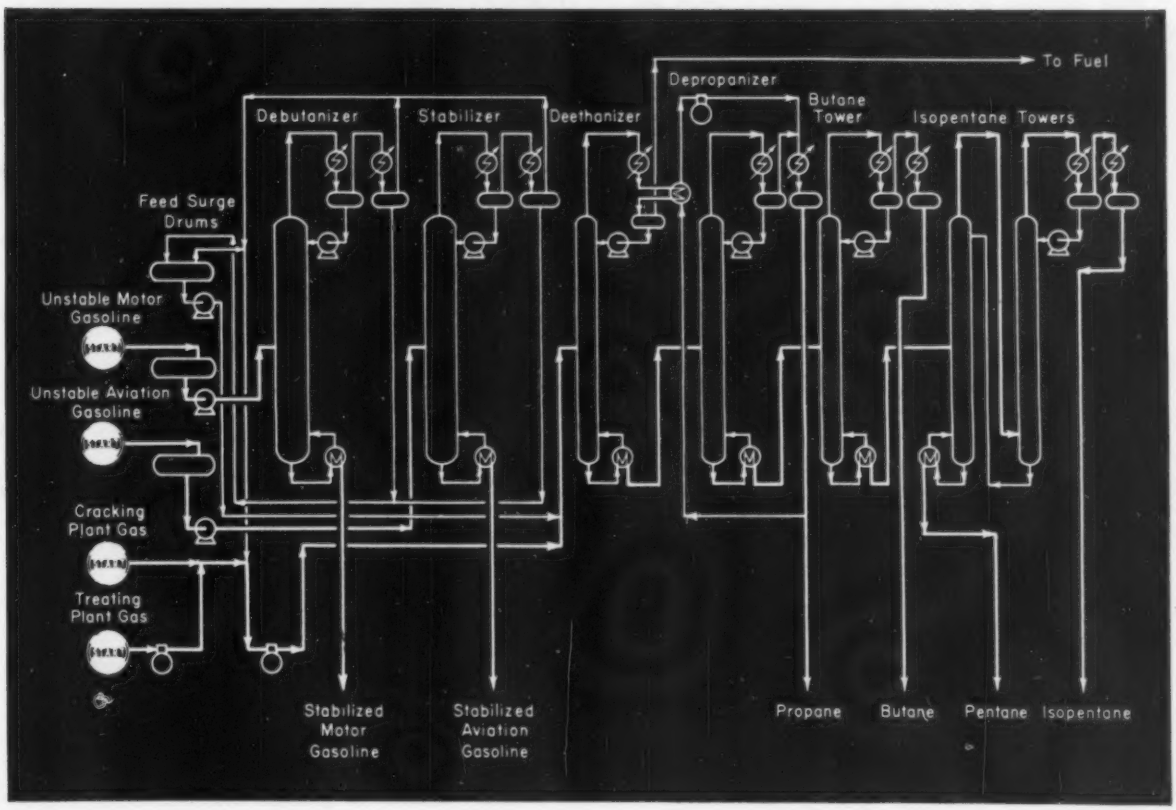
Aviation gasoline from the treating unit is stabilized at approximately the same pressure, also to obtain maximum recovery of the overhead as liquid, and the stabilized gasoline is pumped to storage. The liquid overhead products from the debutanizer and stabilizer are pumped to a surge tank from which they are sent to the de-ethanizer.

Cracking-unit gas is received at 50 psig. The smaller amount of treating-unit gas, available at lower pressure, is compressed to 50 psig, and these streams are combined with the small flow of overhead gas from the debutanizer and stabilizer, compressed, and discharged into the de-ethanizer which operates at 450 psig. The overhead from this column at 125 F. is water-cooled and then refrigerated, providing reflux at a temperature of 45 to 50 F. The possibility of hydrate formation precludes the use of lower temperatures. The refrigeration unit uses propane as the refrigerant. Refrigeration is effected by the evaporation of plant propane in a kettle-type tubular unit. The propane vapor is compressed and then condensed in the depropanizer overhead product condenser. Net de-ethanizer overhead product gas goes to plant fuel.

De-ethanizer bottoms are depropanized at 250 psig. In this column, commercial propane is produced overhead. The bottoms are sufficiently depropanized so that the subsequent butane product will contain less than 1 mol percent propane. The butane tower operates at 100 psig and is designed to make a sharp separation between normal butane in the overhead and isopentane in the bottoms. The bottoms from the butane tower is feed for the isopentane column. This column, operating at 22 psig, is designed to produce overhead an isopentane fraction of 98 percent purity. The bottoms from the isopentane column comprising normal pentane and heavier are pumped to storage and used in motor-gasoline blends. Although two isopentane towers are shown in the flow diagram, it will be noted that process-wise they actually constitute one tower. A split tower was used since the height of a single tower would have been excessive for this particular installation.

Selective Adsorption has been proposed as a method for gas recovery in refineries. In the Hypersorption process (Union Oil Co. of California), the light hydrocarbons are separated selectively by a moving bed of activated charcoal. This method is not generally applicable to refinery processing, but is better reserved for petrochemical service, e.g., processing the residual gas from a refinery. Details and a flow diagram may be found in the Petrochemical Handbook (PETROLEUM REFINER, November, 1957, Page 301).


Residue Gas
Sponge Oil
Refinery Gas
Unstable Gasoline
Fractionating Absorber
Debutanizer
Depropanizer
Propane-Propylene
Butanes-Butylenes
Stabilized Gasoline


To Fuel
Depropanizer
Debutanizer
Stabilizer
Deethanizer
Butane Tower
Isopentane Towers
Feed Surge Drums
Unstable Motor Gasoline
Unstable Aviation Gasoline
Cracking Plant Gas
Treating Plant Gas
Stabilized Motor Gasoline
Stabilized Aviation Gasoline
Propane
Butane
Pentane
Isopentane

Alkylation—What You Should Know

This comprehensive article tells of the many factors which influenced the alkylation process and its products

R. E. Payne
The Pace Company, Houston

ALKYLATE is a very desirable component for a motor fuel blend. As the octanes of motor gasoline continue to rise, alkylate usage will increase rapidly and plateau in the early 1960s. In this plateau era alkylate will make up as much as 40% of premium gasolines and 15% of the total pool.[37] Until recent years alkylate was used almost exclusively in aviation gasoline manufacture. Consequently, government interest in the process has been high and plant capacities and process experience information has been limited by restrictions during the war years.

Here are some of the commercial aspects of alkylation —plant designs, operating techniques and process variables. Details are given for investment and operating cost information, and some octane blending data are presented. To round out the story, process history and theory are sprinkled in to guide the presentation.

ALKYLATION GROWS

Pushed by the aviation gasoline demands of World War II, plant capacities mushroomed from nothing in 1938 to 158,000 bpd by 1946. Between 1939 and 1946, 59 plants were built of which 27 employed the hydrofluoric acid catalyst.[47] This growth is pictured in Figure 1. Immediately after the cessation of World War II, the demand for aviation alkylate dropped and between 1946 and 1951 about half of the plants were shut-down and several were dismantled. In the early stages of the Korean conflict only 35 plants were running, producing 127,000 bpd of alkylate. In 1951 the Petroleum Administration for Defense began pushing for additional alkylation capacity. The goal was to obtain 26 additional plants; construction was encouraged by fast tax write-offs and government contract guarantees. Also, rising aviation gasoline demands commanded new interest for alkylation.[46] By 1955 alkylation capacity had jumped to 227,000 bpd and 60 plants were operating.[49]

Up until this time, most, if not all, of the aviation alkylate had been used in making aviation gasolines. Beginning in 1955 with the rapid rise of motor gasoline octanes, alkylate was used to augment reformate to make premium motor fuels. Since 1955 capacity has climbed steadily and in mid-1958 production capacity stands at 300,000 bpd. In 1959 it is estimated that capacity will approach 362,000 bpd[50] from over 90 operating plants.

A listing of plants by type, location and capacity is given in Table 1. Throughout the entire period, the sulfuric to hydrofluoric acid capacity has been about 3.5 to 1. Because hydrofluoric acid plants are usually constructed with smaller capacities the ratio of sulfuric to hydrofluoric acid plants has been about 2 to 1.

HOW THE PROCESSES WORK

Sulfuric acid and hydrofluoric acid alkylation are very similar. They differ in the level of refrigeration and in the catalyst regeneration technique. HF alkylation has the advantage of operating with cooling water as refrigerant; catalyst is regenerated by simple fractionation. Though several companies design and license each process, the designs for each catalyst differ only in the reaction sections. A basic fractionation system is used in all.

Sulfuric Acid Alkylation. A simplified process flow diagram for sulfuric acid alkylation is shown in Figure 2. The olefin feed, recycle isobutane and acid are contacted in a reaction system. Heat of reaction is removed by a low temperature refrigeration section. The reactor effluent is treated and fractionated to recover recycle isobutane

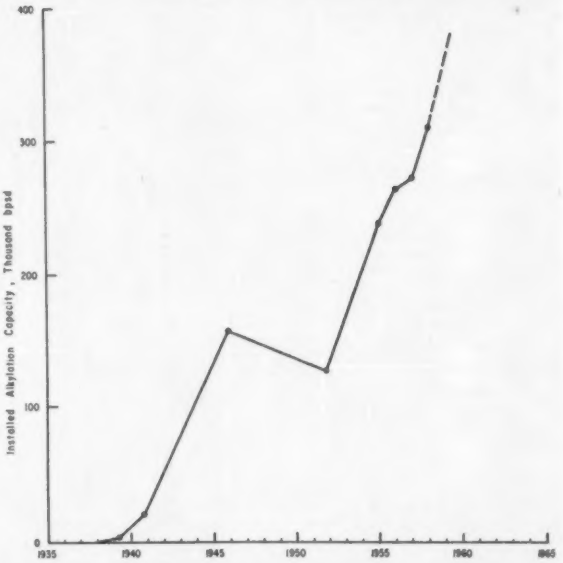


FIGURE 1—Alkylation capacity will continue to grow to furnish a desirable component for premium motor fuel.

About This Process

and alkylate product. Propane and butane feed diluents are rejected. Effluent treating is usually accomplished with caustic and water washing, though new methods using bauxite or hot water washing are now available. Reaction sections differ in olefin and isobutane contacting and in refrigeration techniques. The three most common designs are as follows:

- The Stratco stirred contactors
- The Kellogg autorefrigerated reactors
- The time tank contactors

The time tank reactor was the original design used by the developers of the process. This reactor is a vertical chamber either opened or baffled through which emulsion is circulated by external pumps. Heat is removed by passing the emulsion through external coolers. Emulsion circulation can be either up or down flow with superficial emulsion velocity ranging from 0.1-0.5 feet per second. Olefin and isobutane feeds are dumped into the emulsion transfer line. A slipstream of emulsion is taken to an acid settler where the reactor effluent is separated from recycle and spent acid. Some designs have been improved by installing distributor trays in the vessel and disbursing olefin at these points. This multiple feed point system makes for better product quality and lower acid consumption provided the olefin distributors are properly designed. Several of these reactors are still in use today.

The Kellogg autorefrigerated time tank was an early development which eliminated the external emulsion cooler. The reactor is a horizontal vessel compartmented into reaction, acid settling and product holding sections. Most of these reactors are 10 feet in diameter and liquid level is maintained about seven feet off bottom. The upper third of the vessel is open for disengaging acid from butane vapors which evaporate from the reaction zone. External emulsion pumps are used to circulate the emulsion through internal jet headers distributing the emulsion throughout the reaction zone. Hydrocarbon streams are added to the circulating emulsion just before it enters the reactor.

The Kellogg reactor has progressed through several innovations. Recent designs employ the cascade reactor. In this system the reaction zone is broken into several compartments in series. As many as seven compartments in series have been used; as few as three were employed in the first designs. The reaction emulsion is mixed in each individual compartment by a submerged emulsion pump. Reaction emulsion flows from one zone to the next and finally to the acid settler section which is usually in the same vessel as the reaction zone. Makeup and recycle isobutane are introduced into the first compartment and olefin feed is split equally between the compartments. This design produces an isobutane gradient which results in a higher effective isobutane concentration for the entire reactor. Originally, the cascade reactor employed direct overflow of emulsion into the next zone. This operation was not too successful and it was necessary to install a positive means of achieving this flow. The new design accomplishes this with a seal L-baffle.

Kellogg improvements are discussed by Jewell and King.[27] Old and new reactor designs are compared by Stiles.[38, 42]

The Stratco stirred reactor was used extensively in the

All About Alkylation For Making Gasolines

Alkylation Growth 316
How the Processes Work 316
Remedy Operation Difficulties 320
What Process Variables Do 321
Isobutane Concentration 323
Olefin Space Velocity 323
Reaction Temperature 323
Catalyst Strength 323
Olefin Injection 324
Mixing 324
How Much Acid is Used 325
Try Propylene and Pentylene 326
Blend Alkylate for Octanes 327
The Economics of Alkylation 328

Also

How Alkylation Got Started 320
These Reactions May Occur 325

TABLE 1—Summary of U. S. Alkylation Capacity (Built and Building)

Company	Location	Capacity, bpsd.
SULFURIC ACID CATALYST		
Stratco-Closed Refrigeration		
American Oil Company	Texas City, Texas	9,000
Gulf Oil Corporation	Philadelphia, Penn.	3,200
Richfield Oil Corporation	Wilmington, Cal.	7,000
Shell Oil Company	Houston, Texas	4,900
Shell Oil Company	Norco, Louisiana	7,400
Shell Oil Company	Wood River, Illinois	9,500
Sinclair Refining Company	East Chicage, Ind.	900
Sinclair Refining Company	Houston, Texas	2,900
Sinclair Refining Company	Sinclair, Wyoming	1,800
The Texas Company	Lockport, Illinois	4,400
The Texas Company	Port Arthur, Texas	12,000
The Texas Company	Wilmington, Calif.	4,400
12 Plants		67,400
Stratco-Effluent Refrigeration		
Sun Oil Company	Toledo, Ohio	3,000
The Texas Company	Amarillo, Texas	1,100
The Texas Company	Lawrenceville, Ill.	2,200
The Texas Company	Westville, N.J.	2,200
Socony Mobil Oil Company, Inc.	Trenton, Michigan	3,800
Atlanting Refining Co.	Port Arthur, Texas	2,200
Magnolia Petroleum Co.	Beaumont, Texas	8,000
Shell Oil Company	Anacortes, Wash.	3,000
Standard Oil Company (Indiana)	Sugar Creek, Mo.	3,800
The Texas Company	Anacortes, Wash.	2,200
The Texas Company	Tulsa, Oklahoma	2,200
Texas Butadiene and Chemical Co.	Channelview, Texas	6,300
Pontiac Eastern Corp.	Purvis, Mississippi	2,600
Petro-Tex Chemical Corp.	Houston, Texas	3,000
14 Plants		45,600
Kellogg-Autorefrigeration		
Cities Service Oil Company (Del.)	East Chicago, Ind.	2,600
Cities Service Refining Corporation	Lake Charles, La.	13,500
Standard Oil Company (Indiana)	Whiting, Indiana	5,000
Utah Oil Refining Co.	Salt Lake City, Utah	3,500
4 Plants		24,600
Kellogg-Cascade		
American Oil Company	Destrahan, La.	2,000
Atlantic Refining Co.	Philadelphia, Penn.	5,400
The California Oil Co.	Perth Amboy, N.J.	2,100
Eastern States Pet. and Chem. Co.	Houston, Texas	4,500
Standard Oil Company (Indiana)	Casper, Wyoming	800
Standard Oil Company (Indiana)	Neodesha, Kansas	1,000
Lion Oil Company	El Dorado, Arkansas	1,250
McMurrey Refining Co.	Tyler, Texas	2,200
Ohio Oil Company	Robinson, Illinois	1,500
Standard Oil Company (Ohio)	Toledo, Ohio	5,900
The Shamrock Oil and Gas Corp.	Sunray, Texas	2,400
Socony Mobil Oil Co., Inc.	East Chicago, Ind.	3,200
Standard Oil Co. of Texas	El Paso, Texas	1,600
D-X Sunray Oil Company	West Tulsa, Okla.	2,300
The Pure Oil Company	Toledo, Ohio	1,500
Tidewater Oil Company	Delaware City, Del.	5,000
Socony Mobil Oil Co., Inc.	Buffalo, New York	2,450
Standard Oil Company (Ohio)	Cleveland, Ohio	3,000
Continental Oil Company	Westlake, Louisiana	3,000
19 Plants		51,100
Stratco-Kellogg Combination		
Gulf Oil Corporation	Port Arthur, Texas	9,300
Pure Oil Company	Nederland, Texas	2,900
2 Plants		12,200
Other		
Standard Oil Company (Indiana)	Wood River, Illinois	3,400
Bankline Oil Company	Bakersfield, Cal.	1,000
Esso Standard Oil Co.	Baltimore, Md.	4,500
Esso Standard Oil Co.	Baton Rouge, La.	24,000
Humble Oil & Refining Company	Baytown, Texas	13,000
Shell Oil Company	Wilmington, Cal.	5,800
Standard Oil Company (Calif.)	El Segundo, Calif.	5,400
Tidewater Oil Company	Avon, California	6,000
Union Oil Co., of Calif.	Wilmington, Calif.	5,000
Esso Standard Oil Co.	Linden, New Jersey	10,700
10 Plants		78,800
Total Plants-61		279,700
HYDROFLUORIC ACID CATALYST		
UOP-Stratco		
Continental Oil Company	Ponca City, Okla	5,000
Cosden Petroleum Corp.	Big Spring, Texas	3,700
General Petroleum Corp.	Torrance, California	3,700
National Cooperative Refinery Assn.	McPherson, Kansas	1,700
Sinclair Refining Company	Corpus Christi, Tex.	1,700
Socony Mobil Oil Company, Inc.	Augusta, Kansas	1,450
Socony Mobil Oil Company, Inc.	East St. Louis, Ill.	2,600
Socony Mobil Oil Company, Inc.	Paulsboro, N.J.	2,000
Standard Oil Company (Calif.)	Richmond, Calif.	4,000
Sun Oil Company	Marcus Hook, Penn.	7,000
Suntide Refining Co.	Corpus Christi, Tex.	3,000
Texas City Refining, Inc.	Texas City, Texas	2,500
El Paso Natural Gas Products Company	Gallup, New Mexico	800
Carter Oil Company	Billings, Montana	1,500
Anderson-Prichard Oil Company	Arkansas City, Kan.	1,500
Clark Oil & Refining Co.	Chicago, Illinois	1,500
Cooperative Refinery Assn.	Coffeyville, Kansas	1,600
D-X Sunray Oil Company	Tulsa, Oklahoma	2,600
18 Plants		47,850
UOP		
D-X Sunray Oil Company	Duncan, Oklahoma	3,000
Anderson-Prichard Oil Company	Cyril, Oklahoma	2,400
Ben Franklin Refining Company	Ardmore, Oklahoma	1,000
Leonard Refineries	Alma, Michigan	1,000
American Oil Company	El Dorado, Ark.	1,500
The Pure Oil Company	Lemont, Illinois	1,600
6 Plants		10,500
Phillips-Stratco		
Phillips Petroleum Co.	Phillips, Texas	7,100
Phillips Petroleum Co.	Sweeny, Texas	7,000
2 Plants		14,100
Phillips		
Standard Oil Company (Indiana)	Mandan, N.D.	1,650
Champlin Oil & Refining Company	Enid, Oklahoma	1,450
Skelly Oil Company	Eldorado, Kansas	3,000
El Paso Natural Gas	Odessa, Texas	1,250
4 Plants		7,350
Total Plants-30		79,800
Grand Total Plants-91		359,500

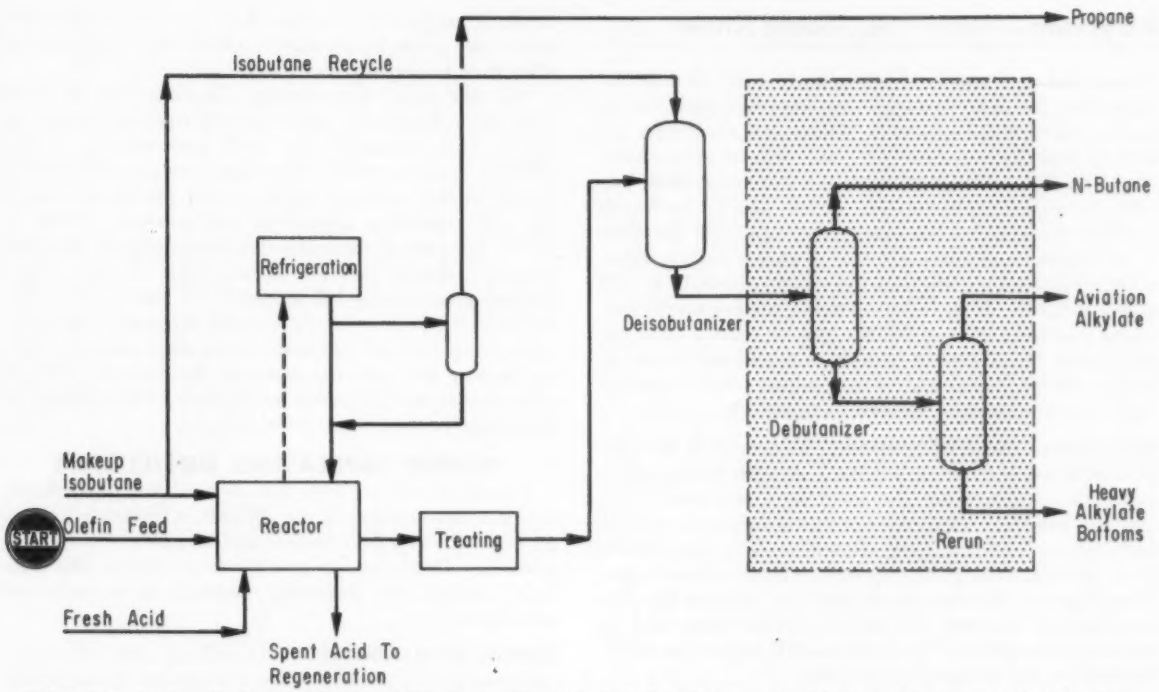


FIGURE 2—In the sulfuric acid alkylation plant, the towers in the shaded portion may be deleted during motor fuel production.

early plants and is the most commonly employed reactor today. This reactor is essentially an over-grown heat exchanger. The emulsion is circulated around the outside of the heat exchanger tubing surface by an internal axial flow impeller. The first contactors were installed vertically and used closed refrigerants such as propane, isobutane, freon or ammonia. This reactor was used exclusively in the war-time hydrofluoric plants and widely in the sulfuric plants. In all, 142 reactors were used, 78 in HF service.

In the early 1950s Stratford introduced two improvements to this design. These consisted of a horizontal contactor and the use of effluent refrigeration.[41, 47] These modifications reduced installation costs and provided more

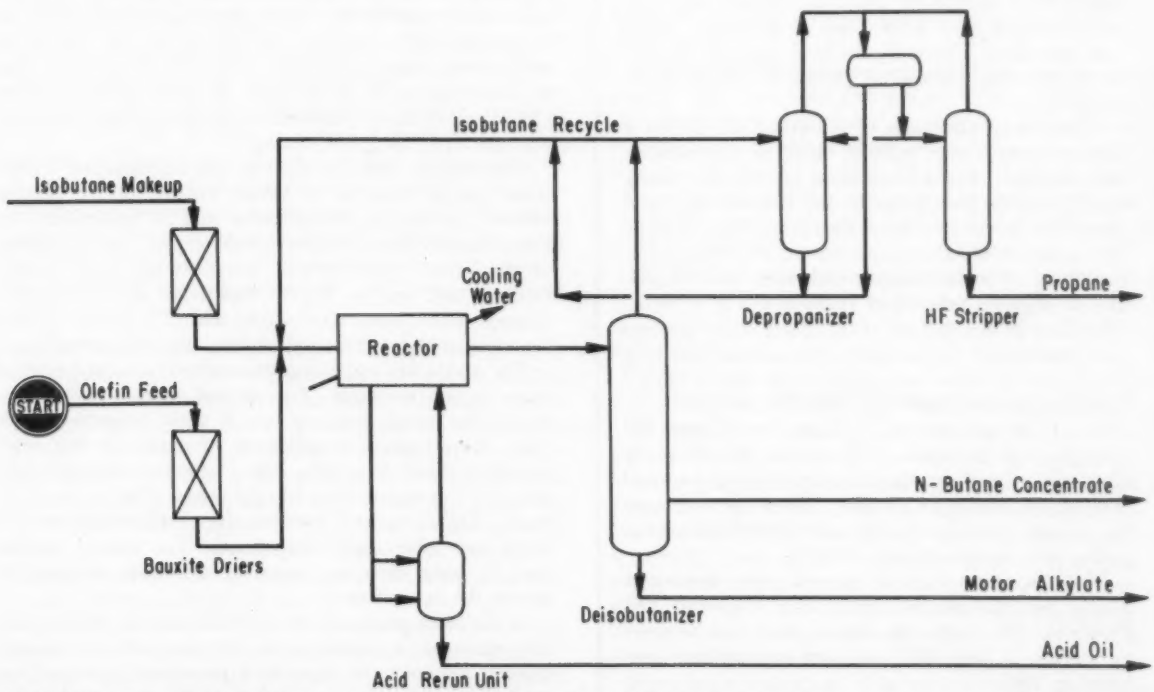


FIGURE 3—These are the minimum process steps of an hydrofluoric acid alkylation plant which are used for motor fuel production.

trouble-free operation. Simultaneously with effluent refrigeration the heat exchanger was improved with the introduction of U-tube bundles. Horizontal contactors are used in both hydrofluoric[5, 12, 20] and sulfuric acid alkylation. To date effluent refrigeration has been used only with the sulfuric acid catalyst. It can also be used with hydrofluoric acid by condensing the vapors off the flash drum without compressing them. A closed cycle refrigeration system which will cool the vapors about 15 F. will accomplish this. Since its introduction, the horizontal contactor has been used in 56,000 bpd of sulfuric acid capacity and 13,000 bpd of hydrofluoric acid alkylation capacity. About 50,000 bpd of new sulfuric acid alkylation capacity has employed effluent refrigeration.

Hydrofluoric Acid Alkylation. The simplified flow for HF alkylation is shown in Figure 3. As with H_2SO_4 alkylation, the reactants are contacted in a reaction section and the products stabilized recovering isobutane recycle and alkylate. Diluents are discarded. The flow shown gives the minimum plant required to produce motor gasoline alkylate. Wartime plants built for aviation gasoline manufacture contained two bauxite defluorinators and an alkylate rerun tower. The standard HF stripper and acid regenerator are included in the flow.

Wartime experiences have been used to good advantage and marked improvements and simplifications have been made in modern HF designs. Late wartime design operations are given by Shanley[16] and Scott.[18] Modern HF alkylation is discussed by several authors.[1, 4, 10, 11]

The first major improvement eliminated the iso-tower feed defluorinator and recovered HF in the isobutane recycle. This innovation cut acid consumption sharply. Modern motor gasoline plants also eliminate the defluorinator on the iso-tower bottoms, and caustic washing is the only treatment applied to unit products. Fired reboilers are used to thermally decompose organic fluorides, thereby reducing net HF consumption further. Other changes combine the HF stripper with the depropanizer; the acid regenerator is smaller and simplified. Some recent plants use reactors made from shell and tube heat exchangers with internal emulsion distributors. This reactor design was pioneered by Phillips; UOP versions are appearing in their most recent plants.

How Alkylation Got Its Start

THE REACTION of isobutane with olefins was first discovered in 1932 by Ipatieff and Pines when they produced alkylate by using $AlCl_3$ promoted with HCl.[23] Although aluminum chloride alkylation is used extensively today to alkylate aromatics and olefins, it finds limited use in alkylating olefins with paraffins. Currently, its only application is in the di-isopropyl process[48] of Phillips Petroleum Company.

Commercial alkylation of isobutane and olefins is predominantly with sulfuric acid or hydrofluoric acid catalyst. The sulfuric acid process was developed jointly by Esso Research and Engineering Company; the British Petroleum Company, Ltd.; Texaco Development Corporation; and Shell Development Company. The first commercial plant was installed at the Baytown refinery of Humble Oil & Refining Company in the fall of 1938. Early developments and commercial experiences were summarized in a joint report by these companies in the fall of 1939.[32] Other companies participating in the early development of the sulfuric acid process were Union Oil Company of California,[36] Universal Oil Products Company, Stratford Engineering Corporation and The M. W. Kellogg Company. Until the war years the process grew slowly and only 20,000 bpd of capacity were in operation in 1940.[43]

The hydrofluoric acid process was developed jointly by Phillips Petroleum and Universal Oil Products. The first commercial plant was brought on stream in late 1942 and first experiences were given in 1943.[2, 19]

REMEDY OPERATING DIFFICULTIES

Process control of both sulfuric acid and hydrofluoric acid alkylation plants is not difficult. Operating troubles generally develop from fouling and corrosion in both processes. Conditions which produce high quality also minimize fouling and corrosion, especially in sulfuric acid alkylation.

Sulfuric Acid Alkylation. In sulfuric acid alkylation corrosion is not severe but has nonetheless been troublesome in most plants. Fouling of fractionation heat exchangers has been severe in heavily loaded plants. Experience has been very good in plants built to produce extremely high quality alkylate.

In the reactor section corrosion is noted where water is in contact with acid. Some plants have corrosion at the feed points where isobutane and olefins are introduced. In the older style time tank reactors, the olefin nozzles suffer severe corrosion. Junction points have shown corrosion where recycle isobutane and refrigerant from the auto and effluent refrigerated systems are mixed. This can be eliminated by mixing some of the recycle acid in to maintain a strong acid environment. In the product caustic wash, corrosion at the point of initial contact can be eliminated by using plastic-lined equipment with adequate pressure drop for good mixing.

The fouling and corrosion in the fractionation equipment can be reduced by better treating of the reactor effluent, by the use of inhibitors and by minimizing reboiler temperatures. Older plants employ batch makeup to the caustic wash system, normally spending caustic from 10 to 2 wt. %. Recent experience shows that continuous makeup and contacting with 2% caustic makes for more complete removal of SO_2 and acid esters.[29]

The alkylation reaction produces both acid and neutral esters as side reactions. The neutral esters cannot be removed by caustic washing and if their concentration is high, they produce troublesome operation in the fractionation train. Recently, two methods have been announced to remove these neutral esters. One by the D-X Sunray Oil Company[26] uses bauxite to adsorb the neutral esters and other acid components. The second process used by some operators employs hot water washing to absorb the neutral esters.

In the older plants where neutral esters are still a problem, corrosion is combatted by injecting various amines, caustic, ammonia or saponified petroleum phenols into the hydrocarbon stream ahead of the first heat exchanger.

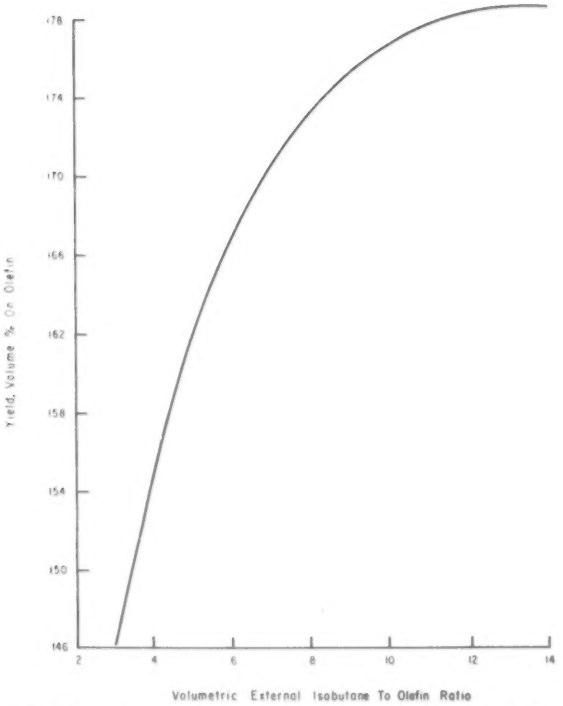


FIGURE 4—The yields from catalytic butylenes in an hydrofluoric acid plant are for a reactor temperature of 80-90 F and reactor acidity of 85-93 weight percent HF.

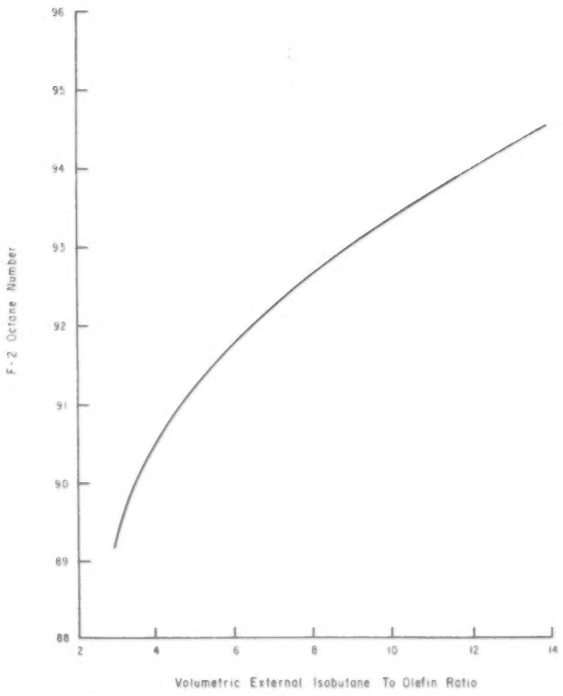


FIGURE 5—The octanes of the aviation alkylate (C_5 to 338 F E.P.) are higher at higher relative isobutane concentrations. The alkylate was produced at a reactor temperature of 80-90 F and reactor acidity of 85-93 weight percent HF.

Inhibitors are sometimes injected into the overhead line of the first fractionator.

Fouling can be minimized by holding down reboiler temperatures. Usually about 50 percent of the ester decomposition occurs in the first fractionator and about equally thereafter in the remaining towers. In the fractionator the feed preheater fouls more rapidly than the reboiler. If the fouling products are not allowed to "bake" onto the tube surfaces, they can be removed by hot condensate washing. Ester decomposition begins to occur at about 170 F and becomes quite rapid above 280 F. Numerous techniques have been employed to minimize reboiler temperatures. Patents have been issued to cover the injection of water and isopentane into the debutanizer reboilers to lower their temperatures. At least one company has used a vacuum rerun tower to lower its reboiler temperatures. Several companies use forced circulated reboilers.

Hydrofluoric Acid Alkylation. Two types of corrosion are experienced in HF alkylation. These consist of iron fluoride deposition and stress corrosion. Although hydrofluoric acid is noted for its corrositivity, carbon steel is used as the major construction material. Hydrofluoric acid attacks the slag formations in welds, and process vessels should be stress relieved and x-rayed. Threaded connections and butt welds should be minimized. All valves, pumps and instrument working parts should be trimmed with monel. In general, the use of chrome and copper alloys should be avoided.

The first point of corrosion usually noted in an HF plant is the preheater for the acid regenerator. This exchanger should be made of monel; lines, pumps, vessels and trays that are directly in contact with hydrofluoric acid should also be made of monel. Corrosion is especially noticeable on the bottom trays of the regenerator tower. Hence, these trays should not be fabricated as an integral part of the tower but should be easily replaceable. On occasions some pitting of the reboiler's shell and tubes has been observed. This is usually the result of excessive temperatures.

Some plants have shown corrosion in the first preheater and the top tray of the first tower. This corrosion can be eliminated by proper operating technique or by the use of monel. Plugging of the debutanizer and rerun towers has been caused by silica migration from the defluorinator. This situation can be improved by designing the defluorinator for low space rates and by using activated alumina instead of bauxite in the defluorinator.

An excellent account of early plant experiences is given by Phillips Petroleum in their book *Hydrofluoric Acid Alkylation.*[25] Other works are reported by Holmberg[14] and Prange.[7]

WHAT PROCESS VARIABLES DO

As with other processes, alkylation technologists evaluate reaction variables by the changes they produce on product quality, alkylate yield and catalyst consumption. Authorities agree fairly well on the variables and on their directional effects. They do not agree on the magnitude of benefits from specific changes. This disagreement is not too surprising since (1) one process change usually affects several variables, (2) benefits are evaluated by as many as four different octane ratings, (3) no common standard alkylate boiling range is rated.

Even more important than these considerations is the fact that all reactors do not respond alike due to design

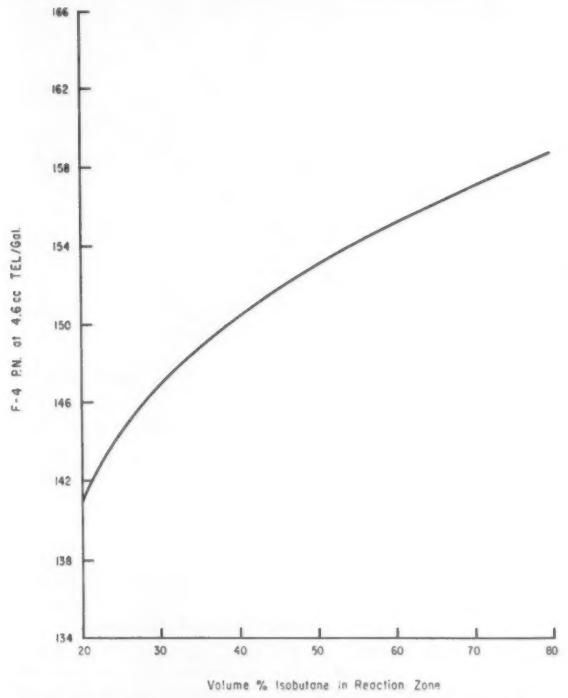


FIGURE 6—Aviation alkylate (C_5 to 338 F E.P.) produced from catalytic butylenes in a sulfuric acid plant are correlated here. The reaction was system controlled at the following conditions: Olefin space velocity of 0.3 vol/hr/vol, temperature of 40-50 F, and acid strength of 90-93 weight percent.

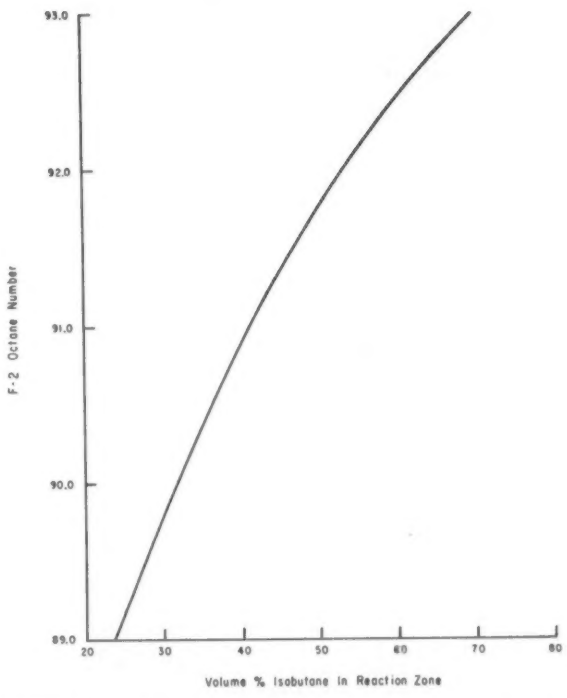


FIGURE 7—These data on the F-2 (Motor) Octane Numbers are for the sulfuric acid alkylation of catalytic butylenes. The reaction is system controlled at the following conditions: Olefin space velocity of 0.3 vol/hr/vol, temperature of 40-50 F, and acid strength of 90-93 weight percent.

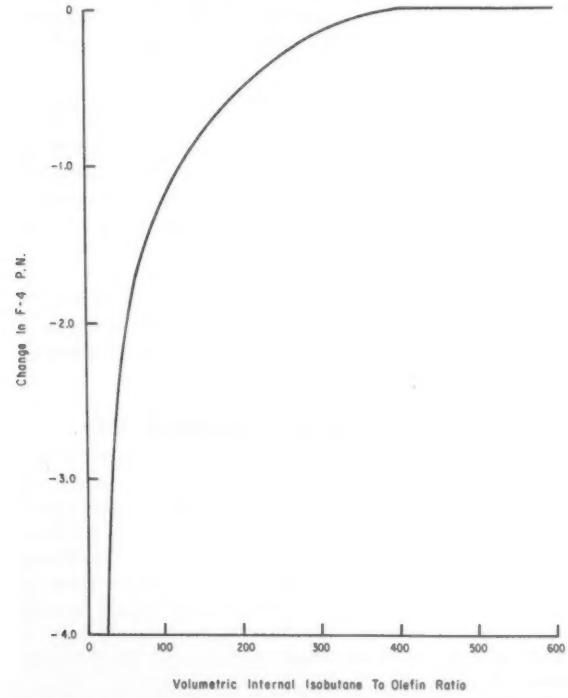


FIGURE 8—Older sulfuric acid alkylation plants usually are injection point controlled and produce a lower grade of alkylate.

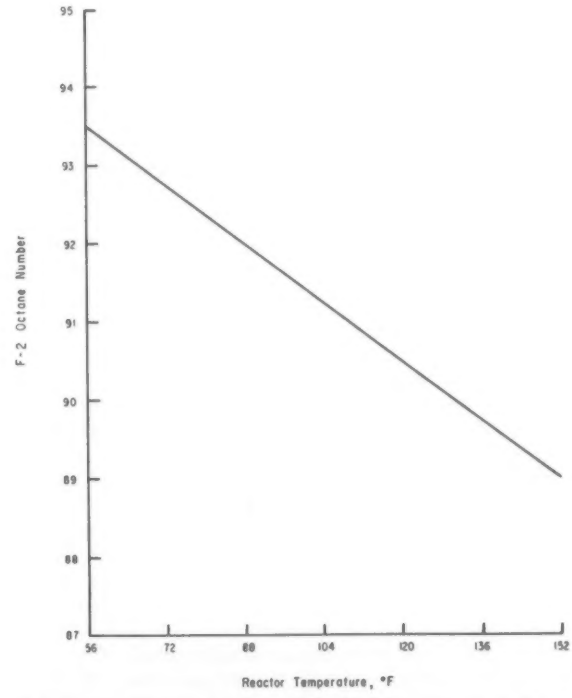


FIGURE 9—These data were obtained at an external isobutane to olefin ratio of 3-12 and an acidity of 85-93 weight percent.

differences which make some injection point controlled and others system controlled. Reactors are injection point controlled when the rate of the reaction is high (high temperature in HF plants) or acid circulation is low as in the older H_2SO_4 plants. Most new sulfuric acid reactors respond to the changes made in the reaction zone and can be referred to as system controlled. System control is achieved by maintaining high acid circulation and low reaction rate (low temperature).

The products of hydrofluoric and sulfuric acid alkylation differ somewhat because the plants are operated at different conditions. At the same conditions, products are quite similar. The same variables affect both processes to varying degrees. The more important variables affecting product quality are:

- Isobutane concentration
- Olefin space velocity
- Reaction temperature
- Catalyst strength
- Olefin injection
- Mixing

Adequate data have been published to relate these variables for butylene alkylation. Little has been done to correlate propylene and pentylene alkylation since these olefins were rarely alkylated until recently. It is common to evaluate these olefins by down-grading butylene correlations. Propylene and pentylene alkylation is discussed later. The following discussions apply to alkylation of mixed butylenes.

Isobutane concentration is correlated differently by various authorities by studying the effect of the external isobutane to olefin ratio, the internal isobutane to olefin ratio or the percent isobutane in the reaction zone. External ratio is defined as the volume ratio of isobutane to olefin in all the incoming feeds to the reaction zone including the recycle isobutane stream.

The internal ratio includes all external isobutane plus that in emulsion circulating past the injection point. In an injection point controlled reactor increasing all three indices of isobutane concentration make for better quality and yield and for lower acid dilution. In a system controlled reactor, internal ratio is so high that additional increases are given no measurable benefit. System controlled reactors can be correlated quite well by using the percent isobutane in the reaction zone. In zones that are in series, the calculated isobutane in the total liquid product from each zone is used. For a single stage reactor the isobutane in the reactor effluent is employed.

Hydrofluoric acid alkylation is correlated by using the external isobutane to olefin ratio. Figure 4 shows the effect of this variable on aviation alkylate yield. Data on F-2 (motor) octane ratings are given in Figure 5. The correlations are based on averages of the data published by Phillips Petroleum,[25] Socony-Vacuum,[17] and Universal Oil Products.[3] Over the normal operating range of 4-10 external ratio, the F-2 Octane Number increases from 90 to 93 and yield of aviation alkylate on olefin increases from 154 to 176 volume percent. These performance ranges are for water cooled reactors running at 80-90 F. with acid stength varying from 85-93 wt. % HF.

Newer sulfuric acid plants are correlated best by using the percent isobutane in the reaction zone. Figures 6 and 7 show the effect of isobutane concentration on aviation alkylate F-4 Performance Number and on total alkylate F-2 Octane Number, respectively. These curves are based on data published for Stratco[30, 44, 45] and Kellogg cascade plants.[42, 51] In the normal operating range of 50-70 volume % isobutane, aviation alkylate F-4 Performance Number increases from 153 to 157. F-2 octane of total alkylate increases about 1.3 units from 91.7.

Older H_2SO_4 reactors using external emulsion pumps usually run at low internal isobutane-olefin ratio and are injection point controlled to varying extents. They do not perform quite as well as the system controlled reactors and must be down-graded. Figure 8 can be used to derate this type of reactor after first estimating the base performance of a system controlled reactor. This curve is based on the published performance data of Kellogg jet reactors.[35, 39]

Olefin space velocity is a measure of catalyst utilization. It is defined as the volumes of olefin feed per hour per volume of active catalyst. The catalyst inventory in the acid settlers is not used in calculating this variable. Space velocity has little or no effect on reactors controlled by injection points. Hence, this variable was not studied definitively in early operations. The variable was indirectly considered by means of the hydrocarbon contact time in the reaction zone. Contact times of 20-30 minutes were used in H_2SO_4 designs and 8-20 minutes in HF designs. Contact time is the time that the total hydrocarbon stream would be in the reaction zone if no acid were present.

Over the usual operating ranges HF operators noticed no effect of contact time. Plants having more than one reactor were often operated with one down without showing any loss in product quality; hence, space velocity is not recognized as a variable in HF correlations. However, if the contact time is too low at cold temperatures, the reaction is incomplete.

Sulfuric acid alkylation plants whose reactors are system controlled respond readily to olefin space velocity. Doubling space velocity in both the Stratco and Kellogg cascade reactors degrades aviation alkylate quality about one octane number or 3-4 F-4 Performance Numbers.[51] This rule plus Figures 6 or 7 can be used to predict reactor perfomance for any combination of isobutane purity and space velocity. For example, a system controlled reactor running at 0.6 vol/hr/vol space rate would produce alkylate quality about four performance numbers below that shown in the figure.

Reaction temperature causes effects which are most pronounced in injection point control reactors. Varying the temperature of 125 from 60 F. in HF alkylation degrades the alkylate quality about three octane numbers. This effect is shown in Figure 9.

In an injection point control sulfuric acid reactor such as the ones described by Wall, the effect of varying reactor temperature from 35 to 55 F. is five performance numbers[40]. In a more completely mixed reactor as described by Stewart the effect of temperature over this same range is only three performance numbers.[51] The Stratco reactors which are definitely system controlled show little effect of temperature changes over the range of 40-55 F.

With both catalysts, increasing temperature increases total alkylate yield as long as polymerization is not excessive. However, high temperature reduces aviation alkylate yield and alkylate quality in sulfuric plants.

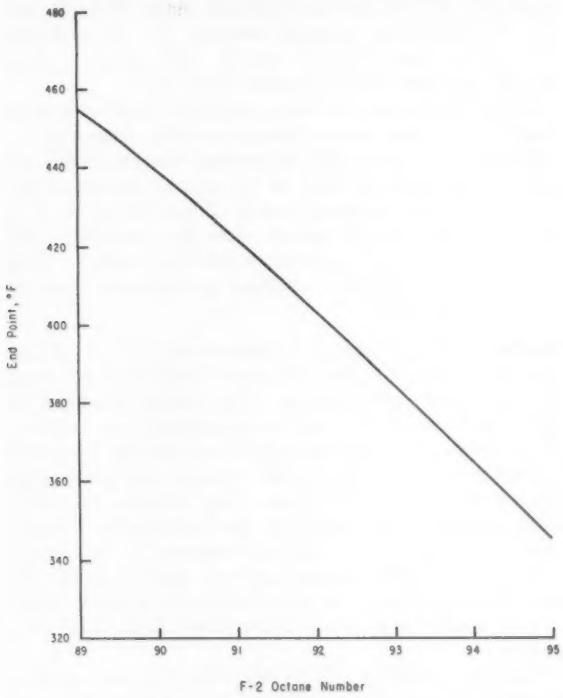


FIGURE 10—The heavy materials in alkylate reduce its octane.

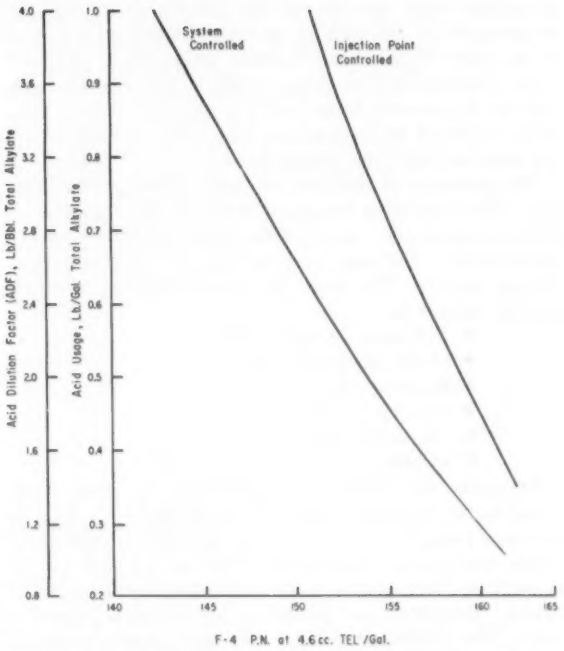


FIGURE 11—These data on acid usage were obtained while operating sulfuric acid plants at temperatures of 40-50 F. The makeup acid strength is 99.0 weight percent and the spent acid is 90.4 weight percent with dilution independent of discard strength.

Catalyst Strength causes varying effects on alkylate quality depending on the water content[6] of the acid and the type reactor employed. Over the range of 80 to 95 wt. % HF, acidity is not as important as in sulfuric acid alkylation. The F-2 O.N. of rerun alkylate changes less than one unit. Highest octane number is attained in the 87-89 percent acidity range.[17] A slight effect of acidity is shown on aviation yield. Also increasing acidity makes for less organic fluoride formation.[25]

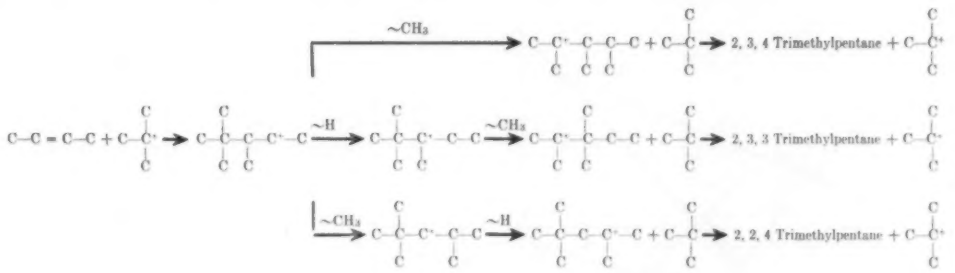
In sulfuric acid alkylation the water content and the reactor mixing determine the benefits derived from variations in acidity. The water concentration in spent acid lowers the activity of the catalyst about 3-5 times as fast as hydrocarbon diluents, thus an 88 percent acid containing 5 percent water would be a much poorer alkylation catalyst than the same strength acid containing only 2 percent water. Reactors which employ less mixing than others should be operated at higher acid strengths to keep acid dilution down[28]. For an injection point controlled time tank reactor Wall indicates that increasing acidity from 89 to 93 wt. % increases aviation alkylate quality three F-4 Performance Numbers.[40] Over this same acid range, Putney shows the improvement is 1.3 octane numbers equivalent to approximately five performance numbers in the system controlled Stratco contactor.[47] On the other hand, in a Kellogg cascade reactor which is also system controlled Stewart shows an improvement of only 1.5 performance numbers.[51] The improvement is small because the water content of acids from Kellogg reactors is normally higher than from the Stratco design.

TABLE 2—Range of Operating Variables in Alkylation

	Hydrofluoric Acid	Sulfuric Acid
1 Isobutane Concentrations		
Volume Percent in Reaction Zone	30–80	40–80
External Ratio to Olefin	3–12	3–12
Internal Ratio to Olefin	.....	50–1000
2. Olefin Concentration		
Total Hydrocarbon Contact Time, Min.	8–20	20–30
Olefin Space Velocity, B/Hr/B	.....	0.1–0.6
3. Reaction Temperature, °F	60–125	35–60
4. Reaction Acidity, Weight Percent	80–95	88–95
5. Reaction Pressure	Maintain Liquid Phase	Maintain Liquid Phase
6. Mixing Level	Low-sufficient for heat transfer	High
7. Acid in Emulsion, Volume Percent	25–80	40–60

The olefin injection is not as critical in the HF process as in the sulfuric acid process since the HF reaction normally is faster. In sulfuric acid alkylation the olefin injection technique has limited effect on alkylate quality but it determines in a large way the aviation alkylate yield on total alkylate and the acid dilution. High olefin loading of the circulating emulsion can increase acid usage 40 percent and lower rerun alkylate yield by 2-5 percent. It is desirable to disperse the olefin as fast as possible as it is introduced into the reaction mixture. A common practice in the older plants is to dump olefin into the emulsion circulating line. Usually emulsion circulation is low enough that a temperature rise in the transfer line is measurable. In this reactor acid consumption is high—about one pound per gallon total alkylate. Only with proper injection and other favorable alkylation conditions can low usage be attained.

These Reactions Occur During Alkylation



The alkylation of isobutane with olefins is complex. It is characterized by simple addition and by numerous secondary (side) reactions. Not all secondary reactions are bad since they make possible the formation of iso-octanes from propylene and pentylene olefins. Primary reaction products are the isomeric paraffins containing carbon atoms that are the sum of isobutane and the olefin. Secondary products are both lighter and heavier than the primary products.

It is generally believed alkylation proceeds through a carbonium ion formed from the isobutane in the presence of the acid catalyst. The carbonium ion reacts with the olefin to produce a heavier ionic structure which in turn reacts with isobutane to produce the primary reaction product and a new carbonium ion to continue the general reaction.[22] The primary alkylation reaction is favored by short contact time, low reactor temperature and high catalyst activity.[22] The ease of alkylation increases with increasing molecular weight of the olefin. The primary reaction for isobutane and butene-2 is illustrated in the accompanying equations.

Secondary alkylation reactions are favored by high temperature, long residence time and high isobutane availabil ty. Some of the secondary reactions which are experienced in alkylation are:

HYDROGEN TRANSFER OR SELF-ALKYLATION —The hydrogen transfer reaction explains the formation of propane and iso-octanes when propylene is alkylated with isobutane. It also explains the formation of isopentate and the iso-octanes when pentylene olefins are alkylated. Since isobutane is alkylated with itself in a sense, its consumption is very high when the product quality of propylene or pentylene alkylate approaches that from butylenes.

DESTRUCTIVE ALKYLATION—This reaction explains the formation of isopentane and isohexane when propylene is alkylated. Similarly, the formation of isopentane and iso-octane is explained by destructive alkylation of pentylenes. Thus, both hydrogen transfer and destructive alkylation help to increase the product quality of pentylene alkylation when isobutane ratios are high.

POLYMERIZATION—When the availability of isobutane is limited or mixing is poor, the olefin tends to react with itself. It can react to form true polymers or conjunct polymers. Undoubtedly, some primary reaction products are made from the reaction of the polymers with isobutane. The unsaturated products of polymerizations are found in the alkylate bottoms.

CATALYST COMPLEX AND ESTER FORMATION —Reaction conditions which favor polymerizat'ons also favor the formation of catalyst complexes and esters. The catalyst complex appears as a brownish-red sludge in the catalyst phase. The esters are distributed between both the catalyst and hydrocarbon phases and should be removed from the hydrocarbons before fractionation. Conditions which make for good alkylate quality inhibit the formation of complexes and esters.

These secondary reactions are discussed in detail by Iverson and Schmerling.[24] Alkylation theories are presented by McAllister[23] and Gorin.[22]

Mixing is much more important in the sulfuric acid process because the catalyst is more viscous, isobutane solubility is lower, and reaction rate is slower. The level of mixing intensity is low in HF plants and need be only sufficient to maintain the emulsion and heat transfer. The original plants were provided with mixing intensities of the same order as those in sulfuric acid plants. It soon became obvious that the high level was not needed and later plants were installed with much less mixing horsepower. It is reported that some plants have operated with mixers turned off. In some new designs internal agitation is not provided and the only mixing provided is the pressure drop across orifices contacting feed with circulating emulsion.

In sulfuric acid plants it is very important that the olefins be distributed as rapidly as possible throughout the entire reaction zone. Low head, high circulating mixers are usually best for this job. Multiple feed point and/or multiple jets at each feed point are beneficial. Dividing the feed into as fine a stream as practical is recommended. Mixing and olefin injection go together toward making the reaction system controlled so that maximum product quality is produced at minimum acid dilution.

The ranges of the process variables are summarized in Table 2 for both HF and H_2SO_4 alkylation. A convenient index of alkylate quality is given in Figure 10 which relates alkylate endpoint with the F-2 O.N. of total alkylate.

ACID USAGE

The actual consumption of acid in either HF or H_2SO_4 alkylation is low—about 0.2-0.5 pounds per barrel of total alkylate. In both the HF and H_2SO_4 processes the reaction acid is diluted by an acid oil polymer which is formed by side reactions. Since the HF spent catalyst is regenerated in the alkylation plant by fractionation, the net consumption for this process is about 0.4 pounds/barrel total alkylate. Consumption is also minimized in new plants by thermo-decomposition of organic fluorides. Sulfuric acid is not usually regenerated at the plant site, and its usage is 0.3-1.0 pounds per gallon of total alkylate due to polymer oil dilution. The formation of acid oil polymer varies with alkylation conditions and olefin type feed stock. In both HF and sulfuric alkylation polymer oil formation is reduced by favorable alkylation conditions; hence, high quality plants in operation today are all de-

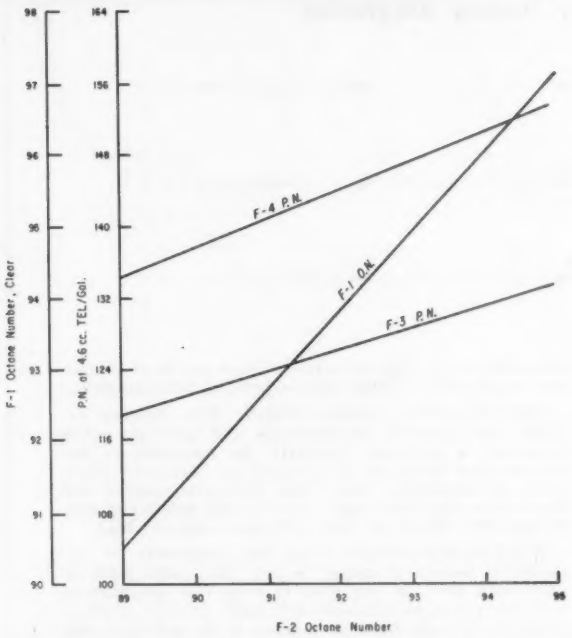


FIGURE 12—Octane ratings of aviation alkylate are related for hydrofluoric acid operation at temperatures of 80-110 F, external ratio of 3-12, and acid strength of 85-93 weight percent.

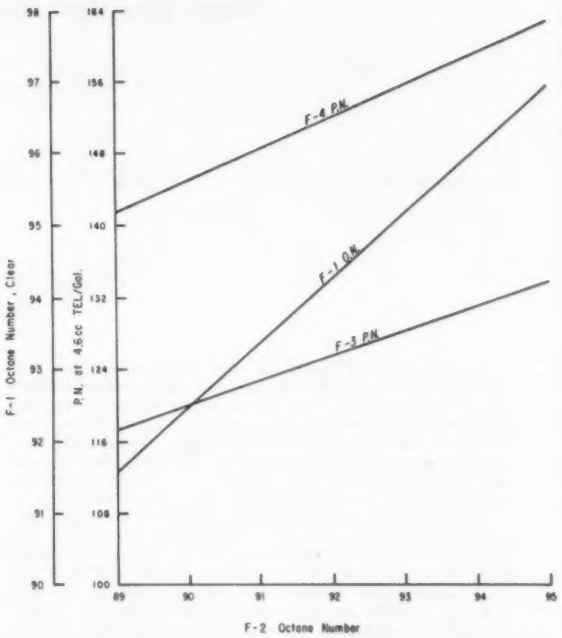


FIGURE 13—The octane ratings of aviation alkylate are related to its F-2 (Motor) rating. The material was produced by sulfuric acid alkylation of catalytic butylenes.

signed for very favorable alkylation conditions and low acid dilution is experienced.

The acid usage in a sulfuric acid plant can be conveniently expressed by an acid dilution factor (ADF). The ADF is dependent on the reaction conditions and acid usage is a function of the dilution range. This concept is discussed by Bowerman and Filbert.[31] They define acid usage according to the following formula:

$$U = P\,(ADF)\left(\frac{C}{C_o - C}\right)$$

Where U = Acid Usage, pounds per day
P = Alkylate production, barrels per day
C_o = Inlet Acid Strength
C = Outlet Acid Strength
ADF = Acid dilution factor, pounds per barrel of total alkylate

TABLE 3—Quality and Yield Ranges for Alkylation

	HYDROFLUORIC ACID			SULFURIC ACID		
	Propylene	Butylene	Pentylene	Propylene	Butylene	Pentylene
1. Yield Factors, Vol. % in olefin						
Propane	7–20	.....	.....	.....	.....	.....
Butane	0–5	0–3	.....	.....	.....	.....
Pentanes	.....	3–15	15–40	4–8	4–12	10–30
Co-338 EP Alkylate	160–175	140–170	140–160	160–175	140–170	135–160
Alkylate Bottoms	5–15	3–20	15–25	5–15	5–20	15–30
2. Isobutane Consumption, Vol. % on olefin	120–170	110–130	90–125	115–135	100–125	90–125
3. Acid Usage						
H_2SO_4 Lb./Gal. TA	.....	.....	.....	1.0–3.0	0.4–1.2	0.7–2.0
HF Lb./Bbl. TA	0.45	0.40	0.45	.....	.....	.....
4. Product Quality						
Total Alkylate						
F-1 O.N. (Clear)	87–91	90–96	87–91	87–91	91–97	88–92
Rerun Alkylate						
F-1 O.N. (Clear)	88–92	91–96	88–92	89–93	92–98	89–94
F-2 O.N. (Clear)	87–90	90–94	87–90	87–91	90–95	87–91
F-3 P.N. + 4.6 cc TEL	120–123	124–132	120–125	112–120	118–128	115–122
F-4 P.N. + 4.6 cc TEL	130–140	140–152	135–144	130–143	145–162	135–148

By using this method the relative consumption of different reactors can be evaluated even though the reactors are running at different acidities. The method also makes possible the evaluation of process variable changes on acid consumption. Figure 11 shows a plot of the acid dilution factors for system and injection point control reactors. The injection point curve is for reactors running with an internal ratio of 50-150. At constant product quality, consumption in this old type reactor is approximately 40 percent greater than in well mixed reactors.

Reactor temperature also affects acid dilution. Each five degree Fahrenheit rise increases the dilution rate 10-15 percent. Of course, feed impurities such as mercaptans, butadiene, sulfur compounds and basic components increase acid dilution.

PROPYLENE AND PENTYLENE ALKYLATION

Propylene and pentylene olefins are usually alkylated in admixture with another olefin. These olefins can be alkylated alone though extremely high sulfuric acid usage is experienced with 100 percent propylene. Operators discovered early that other olefins promote propylene alkylation, and at least 15 percent butylene and pentylene should be included with propylene.

The HF consumption for these olefins is about the same as for butylenes. Acid-polymer formation is more rapid and acid dilution is faster. Hence, additional acid regeneration is required. Acid dilution is also faster in H_2SO_4 alkylation and usage is correspondingly higher. In the past propane recoveries were less and fractionation poorer than today. Hence, high ethylene content produced erroneously high acid usage for propylene olefins. Normally,

propylene acid consumption is three times as great as butylene; pentylene usage is 1.5-2.0 times butylene requirement.

Alkylation plants which charge propylene and pentylene olefins should be designed carefully since secondary reactions can sky-rocket isobutane consumption; especially in HF plants. This high isobutane consumption is especially bad in propylene alkylation since one of the favored products is propane, a low value component. On the credit side, high isobutane consumption does increase trimethylpentane formation and alkylate octane number.[25]

The F-4 Performance Number of propylene aviation alkylate from sulfuric acid is 18-21 numbers lower than butylene alkylate.[34, 51] Pentylene aviation alkylate is about 10 to 14 performance numbers lower than butylene depending on the pentylene isomers present in the feedstock. The quality spread between HF propylene, pentylene and butylene alkylates is less, as is shown in Table 3.

BLEND ALKYLATE FOR OCTANES

Until recently alkylate was rerun to produce aviation alkylate and bottoms. Hence, most of the available data relating the various octane indices of alkylate are based on the aviation fractions. Only recently has any information become available on the octane values of total alkylates. Since HF alkylates are of slightly different composition than sulfuric alkylates, different relations for each must be established. Figure 12 shows the inter-relation of the invoices for HF aviation alkylates. Similarly, Figure 13 shows these relations for H_2SO_4 aviation alkylates. The yields of aviation alkylate on total alkylate are given in Figure 14 for both processes.

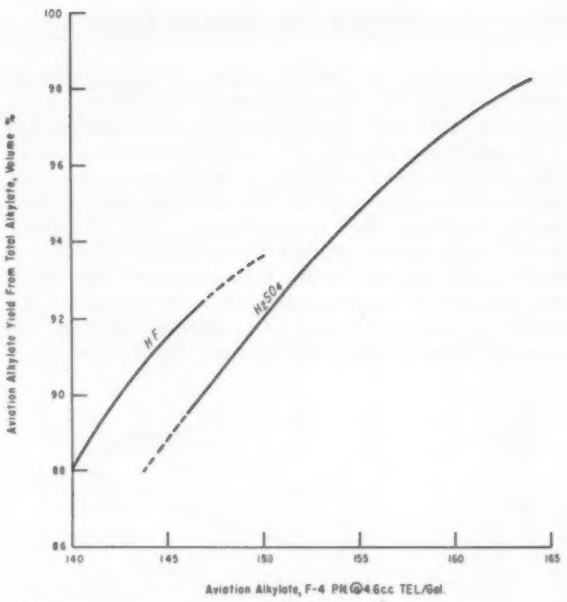


FIGURE 14—This shows how much aviation alkylate (C_5 to 338 F E.P.) can be obtained from the total alkylate product.

The leaded F-1 and F-2 Octane Numbers of total alkylate and the F-2 Octane Numbers of aviation alkylate are related to the F-2 Octane Number of total alkylate in Figures 15 and 16 for HF and H_2SO_4 alkylates, respectively. While these relations are of value, they do not

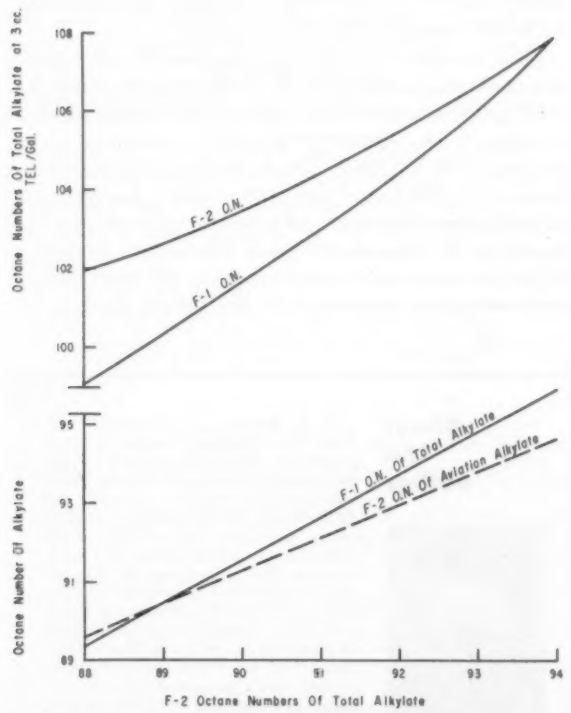


FIGURE 15—Total alkylate from charging catalytic butylenes to an hydrofluoric acid unit gives leaded octane ratings with negative sensitivity even though the unleaded material exhibits a slight positive sensitivity. The dashed line is for the aviation alkylate portion of the product.

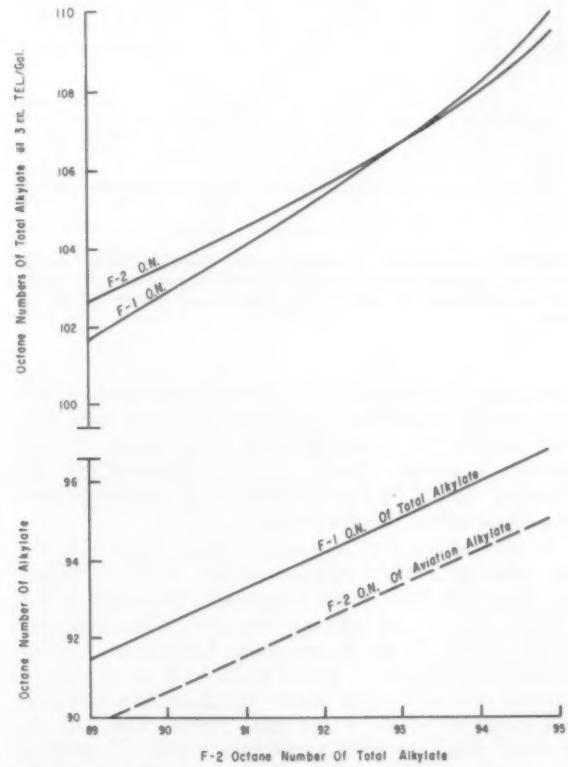


FIGURE 16—Alkylate from sulfuric acid plants has a greater octane sensitivity than that from hydroflouric acid plants.

necessarily reflect the blending values of total alkylate in motor gasoline. The blending value of alkylate in a gasoline pool varies with the inter-actions of the iso-paraffins with olefins and aromatics.[13] Little information is available on this subject and quite a bit of confusion exists. The available data seem to indicate that light alkylate quality has little effect on its blending value. In other words, a low quality alkylate blends almost as well as a high quality alkylate blends. Indications are that this is true for alkylate concentrations up to 40 percent in the blend. Of course, at some point between 40 and 100 percent higher quality alkylate does blend better than

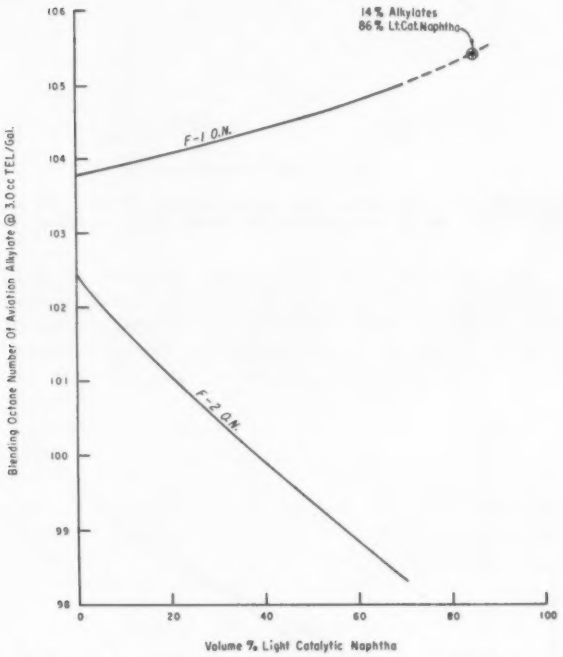


FIGURE 17—Octane blending values were evaluated at an alkylate concentration of 30 percent with exception of one point. In all other cases the third component was a toluene-xylene extract.

lower quality alkylate. Also, high end point total alkylate does not blend quite as high as low end point total alkylate because the concentration of poor quality 350+ F. fraction is greater. There are also indications that the blending value of alkylate is higher when its concentration in a blend is less than 10 percent.[9]

In general, the F-1 (Research) Octane Number blending value of alkylate increases as the olefin content of the blend stock increases. Conversely, the blending F-2 Octane Number of alkylate decreases with increasing olefin content. To get the maximum road octane number benefit from alkylate it should be blended in a balanced gasoline containing both olefins and aromatics. Often, it is possible to obtain a synergistic effect. The data by duPont[8] has been used to prepare Figure 17 showing the average blending values of alkylate in light catalytic naphtha with aromatic extracts.

THE ECONOMICS OF ALKYLATION

The investments for alkylation plants vary as much as 25 percent with the quality level of alkylate product. In the 3,000 bpd capacity range, plants producing nominal quality alkylate cost about $1,000 per barrel. Investments escalate with the 0.65 power of capacity ratio. Investments quoted for new plants in the "Construction Box Score" of the PETROLEUM REFINER indicate that HF alkylation costs somewhat less than sulfuric acid alkylation. It is only fair to add that most of the differences in investment arise from lower quality product or reduced construction standards. Also lower investment is due in part to the elimination of the alkylate rerun facilities in HF motor gasoline plants. Evidently, the new sulfuric acid alkylators are hopeful of getting avgas business and rerunning equipment has been provided in most cases.

In a 3,000-bpd alkylation plant the direct costs of operation including royalty approximate 70-75 cents per barrel. Operating costs of a sulfuric acid plant can be reduced by building for high product quality. Sulfuric acid plants at three quality levels are compared with a motor gasoline HF plant in Table 4. HF and H_2SO_4 operating costs are about equal at the same total alkylate quality level. The table indicates that the operating cost of a high quality sulfuric acid plant is 9 percent less than that of a low quality plant. This reduction comes about from the reduced acid consumption and maintenance required incident to the high product quality. Of course, there is an upper limit for improvement versus product quality. Above 155 performance number operating costs are about constant with product quality.

The economics of a 3,000-bpd plant for HF and sulfuric acid catalysts are compared in Table 5. In this table the 3,000 bpd of total alkylate is blended with regular gasoline components and butane to produce a premium motor gasoline of 99 F-1 O.N. The 3,000 bpd of alkylate produces over 5,600 bpd of premium gasoline. Assuming the following price structure and unlimited sales of premium gasoline at the expense of regular, it is possible to show a 36 percent return on investment for the HF plant and 34 percent return on investment for the sulfuric plant.

About the Author

R. E. Payne is a partner in The Pace Co., Houston, where he is a consulting chemical engineer for the petroleum refining and petrochemical industries. He worked in Humble Oil & Refining Co.'s technical organization from the time of his graduation from college until he joined Pace in 1957. His work for Humble was concentrated in the field of light ends recovery and utilization. Payne's particular interest centered on acid catalyzed reactions, particularly alkylation, and his broad general background was in the production of aviation gasoline. He received a B.S. degree in chemical engineering from Texas Tech in 1949, and is a registered professional engineer in Texas.

Price Structure	Cents/Gallon
Premium Gasoline—99 F-1 O.N.	13.5
Regular Gasoline—91 F-1 O.N.	11.0
Butylenes	12.0
Isobutane	8.0
Normal Butane	5.0

The economic bases for this study were deliberately chosen to present a stand off case for HF and H_2SO_4 alkylation. If the alkylate quality level were different, one process would be favored over the other. At a lower quality level, the investments for each process would go down about equally but H_2SO_4 operating costs would be higher than HF costs. Hence, hydrofluoric acid alkylation would be more economical. On the other hand, if a higher product quality were desired, both investment and operating costs for HF alkylation would increase, and H_2SO_4 alkylation would be preferred. Of course, if aviation gasoline is considered, a H_2SO_4 alkylation plant has an advantage over HF unless very low cost solvent toluene is available to blend avgas.

These numbers reflect an all butylene operation. If propylene or pentylene olefins were alkylated, the economics would vary with each specific case. Plant designs should be considered closely since excess production of propane and pentane is possible in HF alkylation. The debits for turning isobutane into propane could offset the advantages of HF and dictate the selection of a sulfuric plant.

Since the economics are close in most cases, plant selection is often based on sulfuric acid availability. More often than not, a wartime operator of an HF plant will not seriously consider this catalyst if H_2SO_4 is available. This stand is not justified today because marked improvements have been made in HF plant operations. Both catalyst availability and refinery ultimate octane requirement should be determined before a process selection is made.

ACKNOWLEDGMENT

The author wishes to thank The Pace Company for making time available so that this report could be written. Also, the constructive comments by D. H. Ptuney of Stratford Engineering Corporation are appreciated.

LITERATURE CITED

[1] Thornton, D. P., Jr., *Petroleum Processing*, 6, No. 5, p. 488 (1951).
[2] Frey, F. E., *Chem. & Met. Eng.*, 50, No. 11, p. 126 (1943).
[3] Linn, C. B., and Grosse, A. V., *Ind. & Eng. Chemistry*, 37, No. 10, p. 924 (1945).
[4] Resen, F. L., *Oil & Gas Journal*, 51, No. 9, p. 84 (1952).
[5] Thornton, D. P., Jr., *Petroleum Processing*, 9, No. 10, p. 1570 (1954).
[6] Maass, R., *Petroleum Engineer*, 16, No. 5, p. 194 (1945).
[7] Prange, F. A., and Findlay, R. A., *Petroleum Refiner*, 26, No. 3, p. 97 (1946).
[8] duPont Report, "Road Ratings of Tomorrow's Gasolines in Tomorrow's Cars," API Mtg., May 14, 1957.
[9] Webb, O. J., "The Effluent Refrigerated Sulfuric Acid Alkylation Process," AIChE Meeting, Kansas City, Missouri, February 16, 1957.
[10] Hewson, J. E., *Oil & Gas Journal*, 52, No. 46, p. 189 (1954).
[11] Process Handbook, *Petroleum Refiner*, 35, No. 9, p. 250 (1956).
[12] Orr, A. R., *Oil & Gas Journal*, 54, No. 13, p. 102 (1955).
[13] Scott, E. J. Y., "Knock Characteristics of Hydrocarbon Mixtures," API Meeting, May 12, 1958.
[14] Holmberg and Prange, *Ind. & Eng. Chemistry*, 37, No. 11, p. 1030 (1945).
[15] *The Refining Engineer*, July, 1957, p. C-32.
[16] Nebeck, H. J., and Shanley, W. B., *Oil & Gas Journal*, 44, No. 30, p. 94 (1945).
[17] Skinner, E. M., *AIChE Transactions*, 41, No. 6, p. 647 (1945).
[18] Scott, J. A., and Cooper, R. M., *Oil & Gas Journal*, 44, No. 47, p. 204 (1946).
[19] Gerhold, C. G., Iverson, J. O., Nebeck, H. J. and Newman, R. J., *AIChE Transactions*, 39, No. 6, p. 793 (1943).
[20] Orr, A. R., *Petroleum Refiner*, 34, No. 7, p. 165 (1955).
[21] Peters, W. D., and Rogers, C. L., *Petroleum Refiner*, 34, No. 9, p. 126 (1955).
[22] Gorin, M. H., Kuhn, C. S., and Miles, C. B., *Ind. & Eng. Chem.*, 38, No. 8, p. 795 (1946).
[23] Ipatieff, V. N., *Catalytic Reactions at High Pressures and Temperatures*, Macmillan, New York, p. 673 (1936).
[24] Iverson, J. S., and Schmerling, L., *Recent Advances in Petroleum Chemistry and Refining*, Vol. I, Interscience Publishers, Inc., New York (1958).
[25] *Hydrofluoric Acid Alkylation*, Phillips Petroleum Company Publication (1946).
[26] Brant, V. L., *Petroleum Refiner*, 36, No. 9, p. 226 (1957).
[27] Jewell, J. W., and King, C. C., *Petroleum Engineer*, 23, No. 5, p. C-24 (1951).
[28] *Oil and Gas Journal*, 56, No. 19, p. 130 (1958).
[29] Resen, F. L., *Oil & Gas Journal*, 50, No. 42, p. 178 (1952).
[30] Goldsby, A. R., and Putney, D. H., *Petroleum Refiner*, 34, No. 9, p. 148 (1955).
[31] Bowerman, E. W., and Filbert, B. M., *Ind. & Eng. Chemistry*, 40, No. 3, p. 542 (1948).
[32] *Petroleum Refiner*, 18, No. 11, p. 116 (1939).

TABLE 4—Operating Costs

Type of Alkylation	Hydrofluoric Acid	Sulfuric Acid		
Plant Capacity, B/SD	3,000	3,000	3,000	3,000
Product Quality Level				
F-2 O.N. of Total Alkylate	92	91.0	92.3	93.5
F-4 P.N. of Aviation Alkylate	144	151	155	159
Process Investment, $\$\overline{M}$	2.75	2.50	2.75	3.25
Direct Operating Costs, $/D				
1. Salaries and Wages				
2 Operators @ $3/hr.	145	145	145	145
1 Foreman @ $9,000/yr.	25	25	25	25
Clerical	10	10	10	10
Maintenance	225	175	150	140
2. Materials				
Maintenance	175	125	100	100
H_2SO_4-$20/T	.....	770	580	415
HF-$0.23/Lb.	275	.....	.....	.....
Caustic-2.75 ¢/Lb.	15	20	15	15
Other	15	15	10	10
3. Utilites				
Fuel Gas-15¢/$\overline{M}$ Btu	470	65	70	80
Steam-30¢/1,000 Lb.	10	320	350	450
Power-0.8¢/KWH	90	80	115	130
Water-1¢/1,000 gal.	110	90	100	130
4. Royalty*				
HF-20¢/Bbl. TA	600	.....	.....	.....
H_2SO_4-15¢/Bbl. TA	.....	450	450	450
Total Direct Costs	2,165	2,290	2,120	2,100
¢/Bbl. TA	72	76	71	70

* Both royalties apply fully toward a paid up $1.00 per Bbl. for HF and $1.50 per Bbl. for H_2SO_4.

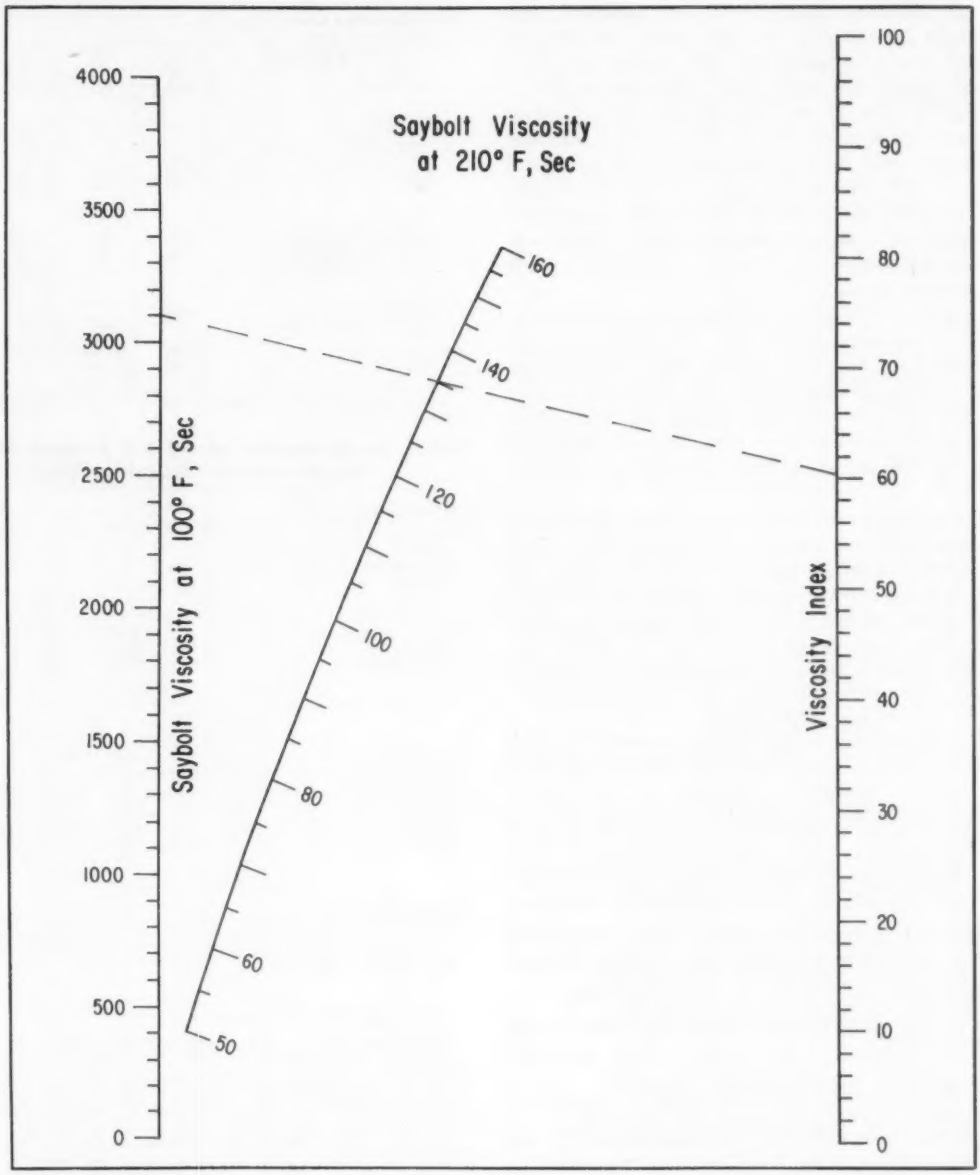
TABLE 5—Economics of 92 F-2 Octane Alkylation Plants—Motor Gasoline Basis*

Alkylation Plant Balance, B/D					HF	H_2SO_4
Butylenes					(1,625)	(1,745)
Isobutane					(2,050)	(1,920)
Total Alkylate					3,000	3,000
Shrinkage					675	665
Total					0	0
Motor Gasoline Balances			B/D	F-1 O.N.	F-2 O.N.	RVP
Total Alkylate			3,000	104.5	100.0	3.0
Regular Mogas			2,245	91.0	82.0	10.0
N-Butane			420	102.5	98.0	60.0
Premium Mogas			5,665	99.0	92.7	10.0
			HF		H_2SO_4	
Refinery Products	¢/Gal.	$/B	B/D	$/D	B/D	$/D
Premium Gasoline	13.5	5.67	5,665	32,120	5,665	32,120
Regular Gasoline	11.0	4.62	(2,245)	(10,370)	(2,245)	(10,370)
Isobutane	8.0	3.36	(2,050)	(6,890)	(1,920)	(6,450)
Butylenes	12.0	5.04	(1,625)	(8,190)	(1,745)	(8,800)
N-Butane	5.0	2.10	(420)	(880)	(420)	(880)
Loss	.....	.....	675	.....	665	.....
			0	5,790	0	5,620
Operating Costs (Table 4)				2,165		2,120
TEL, 0.21 ¢/cc				905		905
Net Credit				2,720		2,595
Return on $2.75 M Investment, %/yr.				36		34

* Parentheses denote negative values.

[33] McAllister, S. H., *J. Org. Chem.*, 6, p. 647 (1941).
[34] Oden, E. C., and Burch, W. J., Jr., *Ind. & Eng. Chem.*, 41, No. 11, p. 2524 (1949).
[35] Oden, E. C., Burch, W. J., Jr., and Jones, G. R., *Petroleum Refiner*, 29, No. 4, p. 103 (1950).
[36] Gard, E. W., Blount, A. L., and Kirpi, K., *Petroleum Refiner*, 18, No. 12, p. 63 (1939).
[37] Service, W. J., Payne, R. E., and Askey, W. E., *Petroleum Refiner*, 37, No. 4, p. 181 (1958).
[38] Stiles, R., *Petroleum Refiner*, 34, No. 2, p. 103 (1955).
[39] Feller, N. N., and France, R. M., *Oil & Gas Journal*, 51, No. 6, p. 354 (1952).
[40] Wall, J. E., *Petroleum Processing*, 7, No. 10, p. 1438 (1952).
[41] Putney, D. H., and Webb, O. J., *Petroleum Refiner*, 32, No. 9, p. 105 (1953).
[42] Stiles, S. R., *World Petroleum*, 1956 Annual Refinery Review, p. 60.
[43] McAllister, S. H., *California Oil World and Petroleum Industry*, November, 1940.
[44] Templeton, P. C., and King, B. H., WPRA Wichita Regional Meeting, 1956.
[45] Brooks, C. H., and Daugherty, J. P., WPRA Forty-Fifth Annual Meeting, 1957.
[46] Bolles, W. L., *Petroleum Refiner*, 30, No. 9, p. 150 (1951).
[47] Putney, *World Petroleum*, 22, No. 6, p. 55 (1951).
[48] Alden, R. C., Frey, F. E., Heep, H. T., and McReynolds, L. A., *Oil & Gas Journal*, 44, No. 40, p. 70 (1946).
[49] *Oil and Gas Journal*, Annual Refinery Capacity Survey, 53, No. 46, p. 208 (1956).
[50] Webber, George, *Oil and Gas Journal*, 56, No. 12, p. 90 (1958).
[51] Stewart, L. D., WPRA Forty-Sixth Annual Meeting, 1958.
[52] Fuson, R. C., *Advanced Organic Chemistry*, John Wiley & Sons, New York (1950).

Find Viscosity Index by Nomograph



D. S. Davis
University of Alabama, University, Ala.

THE VISCOSITY INDEX of oil, based on the relationships of Dean and Davis[2], can be determined quickly and conveniently by means of the accompanying line coordinate chart, which was constructed in accordance with well-known methods.[1]

The use of the chart is illustrated as follows: What is the viscosity index of an oil when the Saybolt viscosity at 100 F is 3,100 seconds and the Saybolt viscosity at 210 F is 135 seconds? Connect 3,100 on the left-hand scale and 135 on the curved scale with a straight line. Extend the line to the right-hand scale and read the viscosity index as 60.5.

LITERATURE CITED

[1] Davis, D. S., "Nomography and Empirical Equations," Chap. 10, Reinhold Publishing Corporation, New York, 1955.
[2] Dean, E. W., and Davis, G. H. B., Chem. Met. Eng., 36, 618 (1929); Nelson, W. L., "Petroleum Refinery Engineering," 3rd ed., p. 92, McGraw-Hill Book Co., Inc., 1949.

From Flow Sheet to Cost Estimate

Here is a series of factors for various items of process equipment which is useful in making capital cost estimates suitable for process evaluation

W. E. Hand
Shell Development Company
Emeryville, Calif.

A SHORT-CUT METHOD of estimating approximate battery limit costs without the aid of plot plans and sketches of piping, platforms, buildings and other structures is a worthwhile tool for use in preliminary process evaluations. One such method which has been used by the author for about 15 years is a variation of the so-called ratio method. This method has proved quite satisfactory for preliminary estimates. Furthermore the cost of making these estimates is far less than that of detailed estimates.

The first requirement for making a capital cost estimate by this method is a process flow sheet showing sizes or other specifications of all process equipment. Secondly, in order to complete estimates without delay, charts and tables of cost of equipment are essential. The third and final requisite is a set of installation factors or multipliers relating total battery limit costs to equipment costs based on past experience with similar process plants. For a plant of the type to be used as an example here the estimated equipment costs are multiplied by various factors (see box).

The sum of these products is the estimated total cost of the plant installed complete inside battery limits.

In a method described by Lang,[1] the total estimated cost of equipment was multiplied by a series of factors to obtain total plant cost. It has been found that for the type of plants encountered by the author the use of different factors for different classes of equipment gives better results.

In order to obtain satisfactory estimates of battery limit costs by this short cut method, factors must be derived either from your recent installations or from detailed estimates of projects meeting your standards for mechanical design and plant layout. Since design standards vary from company to company and occasionally between different locations within the same company it is mandatory that your installation factors or multipliers be derived from, or at least adjusted to your own plant standards.

Multiplying Factors for Equipment Costs

Fractionating Columns	4
Pressure Vessels	4
Heat Exchangers	3½
Fired Heaters	2
Pumps	4
Compressors	2½
Instruments	4
Miscellaneous Equipment	2½

The equipment multipliers selected for this example were determined by analyzing several detailed estimates of plants of the same type. Approximate values of the various components making up these multipliers are shown in detail in Table 1. In this table the purchase price of equipment is shown as 100 percent for each category and all other costs entering into the installation of that equipment are shown as percentages of the equipment cost.

Perhaps the figures in Table 1 require some explanation. As an example, assume that the total estimated cost of fractionating columns on a project is $100,000. Then material for foundations and paving chargeable to columns will be 10 percent of $100,000 or $10,000; piping material 60 percent of $100,000 or $60,000, etc. The total field materials required for installation of these Columns will be 118 percent of $100,000 or $118,000. Field labor will be 82 percent of $100,000 or $82,000. Total direct cost pertaining to columns is the sum of $100,000 purchase price of the columns, $118,000 field materials and $82,000 field labor, or $300,000. Adding indirect costs of $100,000 gives a total of $400,000 as the portion of battery limit cost attributed to fractionating columns.

In order to make an estimate of total cost of a battery limits installation by using the multipliers as previously outlined it is now necessary to have the cost of all process equipment. For a flow sheet type of estimate approximate equipment prices are adequate. In fact the information required to obtain firm quotations on

TABLE 1—Components of Total Battery Limit Installation Cost Expressed as Percentage of Equipment Cost

Cost of Equipment, F.O.B. Factory	Columns 100%	Exchangers 100%	Vessels 100%	Pumps 100%	Compressors 100%	Furnaces 100%*	Instruments 100%	Misc. Equipment 100%
Materials for Field Construction:								
Foundations and Paving	10	5	5	5	5	10	5	5
Platforms and supports	15	25	20	...	...	...	20	10
Buildings	...	...	...	10	15	...	15	10
Piping	60	50	65	30	15	10	50	15
Insulation and fireproofing	25	14	12	7	7	7	7	7
Electrical	5	3	5	75	15	5	40	10
Paint, Clean, Test and Miscl.	3	3	3	3	3	3	3	3
Sub-Total, Field Materials	118	100	110	130	60	35	140	60
Total-Equipment and Field Materials	218	200	210	230	160	135	240	160
Field Labor:								
Handle and Set Equipment	10	3	10	10	10	...	10	10
Other Construction	72	62	80	60	20	15	50	20
Sub-Total, Field Labor	82	65	90	70	30	15	60	30
Total Direct	300	265	300	300	190	150	300	190
Indirect Cost, Approx. ⅓ of Direct	100	85	100	100	60	50	100	60
Total Installation	400	350	400	400	250	200	400	250
Approx. Ratio: Total Installation / Equipment Cost	4	3½	4	4	2½	2	4	2½

* Furnaces priced erected.

equipment seldom is available at this stage of a process evaluation. Therefore approximate prices from charts and tables are just as useful as prices carefully calculated from a design which probably will not bear much resemblance to the final design, when and if a final design is ever developed.

All costs shown in the following tables are early 1958 costs corresponding to an ENR construction cost index of approximately 750.

Columns. In Table 2 the costs of fractionating column shells (carbon steel) including nozzles, manways and base ring but exclusive of trays or other internals are listed opposite the calculated weights of the straight cylinder plus two elliptical heads. In other words, nozzles, manways and other attachments are not included in the weights but they are included in the cost as shown in the table. Since the number of openings is unknown at this stage you must work with averages, and these are built into the costs shown in Table 2. To the cost of the column shell must be added the cost of trays from Table 3.

TABLE 2—Cost of Fractionating Column Shells and Pressure Vessels

Weight, Lbs. (Without Attachments)	Column Cost	Pressure Vessel Cost
1,000	$ 1,500	$ 1,000
2,000	2,400	1,500
5,000	4,500	2,600
10,000	7,500	4,000
20,000	11,500	5,500
40,000	18,000	8,500
60,000	24,000	11,500
80,000	29,500	14,500
100,000	35,000	17,500

TABLE 3
Cost of Steel Bubble Trays Assembled

Diameter, Feet	Cost Per Tray	Diameter, Feet	Cost Per Tray
3	$130	8	$ 675
4	205	9	840
5	275	10	1,030
6	400	11	1,240
7	515	12	1,475

Pressure Vessels. Cost of pressure vessels other than fractionating columns are also shown in Table 2. Because simple pressure vessels such as accumulators, surge tanks and pressure storage tanks have fewer nozzles and manways, fewer miscellaneous attachments and can be built to less rigid tolerances than columns, they cost less per pound than columns. As with columns, costs of pressure vessels including an allowance for nozzles and other attachments are listed opposite calculated weights of bare shells without attachments.

TABLE 4—Cost of Heat Exchangers
¾" x 16 ga. x 16' Tubes, 1" Sq. Pitch, 150 psi Floating Head Removable Bundle

Surface Square Feet	Cost With Steel Tubes	Cost With Admiralty Tubes
200	$ 2,100	$ 2,900
400	2,700	3,600
600	3,300	4,400
800	3,900	5,200
1,000	4,500	6,000
1,500	6,000	8,000
2,000	7,500	10,000
2,500	9,000	12,000
3,000	10,500	14,000

Heat exchangers can be estimated from tables or charts with sufficient accuracy for process evaluation purposes. Table 4 shows the cost of shell and tube units, 150 psi design, removable bundle with ¾-inch O.D. tubes on 1" square pitch. For 300 psi design on both the shell side and tube side the cost will be about 15 percent higher. Extensive information on exchanger costs is available in several papers by Rubin.[2]

Tanks. Costs of cone roof steel storage tanks erected are shown in Table 5. These are West Coast prices. In the Gulf Coast and Mid-Continent areas, costs run 10 to 15 percent less.

Furnaces vary in cost perhaps more than any of the items listed above. Cost erected but excluding founda-

TABLE 5—Cost of Cone Roof Steel Tanks Erected West Coast

Barrels	Cost	Barrels	Cost
1,000	$ 5,000	20,000	$ 27,000
2,000	6,600	28,000	35,000
3,000	8,000	35,000	42,000
4,000	9,500	55,000	60,000
5,000	11,000	80,000	83,000
10,000	16,000	100,000	100,000

tion may vary from $2,000 to $5,000 or $6,000 per million Btu heat absorbed per hour. At the lower end of this scale will be low temperature light duty furnaces such as those for heat medium circulating systems. Costs of high temperature, high pressure cracking and reforming furnaces generally will be near the top of this range.

Pumps. The easiest way to price pumps is by means of an up-to-date price book from one of the leading manufacturers. If a price book is not available, just approximate the small easy ones and ask a pump sales engineer for prices on the big and the doubtful. Here is a safe test to determine whether or not outside help is necessary. Figure the cost on the basis of 50 percent efficiency and $100 per horsepower total for pump and driver for 25 hp. and smaller (but with a minimum of $1000) and $60 per brake horsepower based on 60 percent efficiency above 25 hp. If this total is less than 10 percent of all equipment, use it in your estimate. If more than 10 percent of your total equipment, then get help with any large pumps involved.

Compressors are more hazardous to estimate than pumps because they usually come in larger units. And the price per horsepower may range all the way from $50 to $150 total for compressor and driver. Cost of gas engine diven reciprocators is fairly uniform at about $100 to $125 per horsepower. Both electric and steam driven reciprocators are a little cheaper. For centrifugals a safe rule is to try $100 per horsepower and if the amount isn't too great a proportion of the total equipment cost, use it. Otherwise ask for an estimating price from a manufacturer.

Instrument prices will vary considerably depending on the type used. However for this example lets assume an average of $1,000 per control instrument including control valve. But if you have many 6- or 8-inch control valves add several hundred dollars extra for each of them. For recorders and indicating controllers use about $500-$700 each. To the sum of all these add 25 to 50 percent for pop valves, gages, gage glasses thermometers and miscellaneous instruments.

This method requires . . .

- **Flow Sheets and Specs**
- **Equipment Costs**
- **Installation Factors**

An Example of the use of this technique in estimating the approximate cost of a hypothetical simplified process plant will serve to further explain the method and illustrate the extent of equipment data required for factor estimates. For this example assume that the process flow sheet shows equipment as follows:

Column: 6 feet 0 inches inside diameter, 30 bubble trays at 24-inch spacing, 125 psig operating pressure. Use ⅜-inch thick shell and heads.

Exchangers: Condenser, 2,000 square feet

Reboiler, 820 square feet, kettle type

Cooler, 1,000 square feet.

Accumulator: 5-foot diameter x 20 feet, 125 psig. Use ½-inch thick.

Pumps: Charge and spare—250 gpm, 175 psi differential pressure.

Reflux and spare—100 gpm, 60 psi differential pressure.

Furnace: 10 MM Btu/hr. heat absorbed.

Instruments: 5 recording controllers.
3 indicating controllers
2 flow recorders.

Tank: 5,500 barrel, cone roof, steel.

In preparing a factor type estimate of battery limit cost of this installation, the equipment cost would be estimated as follows:

Column: Height = 80 feet (30 tray spaces at 2 feet each + 10-foot skirt + 10-foot for surge and extra space at manholes.

Weight = 41,650 pounds (80 feet of cylindrical shell at 490 pounds per foot + 2 heads at 1,225 pounds each).

Cost from Table 2	$19,000
30 trays at $400 each (from Table 3)	12,000
Total Column and trays	$31,000

Exchangers:

Condenser, 2,000 square feet, Admiralty tubes	$10,000
Reboiler, 820 square feet, steel tubes. Cost from Table 4 = $4,000. Add 50 percent for kettle	6,000
Cooler, 1,000 square feet, Admiralty tubes	6,000
Total Exchangers	$22,000

Accumulator:

Weight = 20 feet at 325 pounds + 2 heads at 700 pounds = 7900 pounds	
Cost from Table 2	$3,500

Pumps:

Charge: 60 percent efficiency = 40 hp. at $60	$2,400
Spare	2,400
Reflux: 50 percent efficiency = 10 hp. at $100	1,000
Spare	1,000
Total Pumps and Drivers	$6,800

Furnace: Assume that a quick check of data on similar plants indicates that a furnace of this size in this service would cost about $3,000 per MM Btu.

10 MM Btu at $3,000/MM	$30,000

Instruments:

5 recording controllers at $1,000	5,000
3 indicating controllers at $700	2,100
2 flow recorders at $700	1,400
Add for pop valves, gages	

and miscellaneous..... 3,500

Total instruments, including control valves. $12,000

Tank: 5500-barrel. Cost from Table 5..... $12,000

With these estimated equipment costs and the installation factors listed in an earlier paragraph, total battery limit cost is estimated as follows:

	Equipment Cost		Factor		Total Installation
Column	$ 31,000	x	4	=	$124,000
Exchangers	22,000	x	3½	=	77,000
Vessel	3,500	x	4	=	14,000
Pumps	6,800	x	4	=	27,200
Furnace	30,000	x	2	=	60,000
Instruments	12,000	x	4	=	48,000
Tank	12,000	x	2½	=	30,000
Totals before Contingency	$117,300				$380,200

To this should be added a contingency allowance based on your knowledge of the accuracy and completeness of the process design.

In most cases the estimate of total battery limit cost will be all that is required for an economic evaluation of a process. Occasionally however an indication of the amount included for one or more of the field construction items is required. This can be obtained readily by means of the ratios listed in Table 1. In this instance the allowance for piping materials is 60 percent of $31,000 (column) plus 60 percent of $22,000 (exchangers), 65 percent of $3,500 (vessel), 30 percent of $6,800 (pumps), 10 percent of $30,000 (furnace), 50 percent of $12,000 (instruments) and 15 percent of $12,000 (tank) or a total of $44,700. At times it will be possible to estimate one or more field construction items more accurately by some other means. If so, then the total battery limit cost can be adjusted by the amount of variation from the corresponding items obtained by the factor method.

Calculating all the field construction materials, field labor and indirect costs by means of the breakdown given in Table 1 results in the cost distribution as shown in Table 6. From this summary it is obvious that, aside from equipment, the cost of piping, field labor and indirects are the important items in the cost of a plant of this type. And assuming that the estimated cost of equipment is reasonably accurate, the accuracy of the total battery limit figure depends mainly upon how closely piping, field labor and indirect costs fit the average pattern from which the multipliers used here were derived.

TABLE 6

Recapitulation of Costs as Estimated

	Amount	Percent of Total
Equipment		
Columns	$ 31,000	8.1
Exchangers	22,000	5.8
Vessel	3,500	.9
Pumps	6,800	1.8
Furnace	30,000	7.9
Instruments	12,000	3.2
Tank	12,000	3.2
Total	$117,300	30.9
Field Materials		
Foundations and paving	$ 8,915	2.3
Platforms, structures	14,450	3.8
Buildings	3,680	1.0
Piping	44,700	11.8
Insulation, fireproofing	15,520	4.1
Electrical	14,985	3.9
Paint, clean, test	3,515	0.9
Total	$105,765	27.8
Field Labor	63,100	16.6
Total Direct Cost	$286,165	75.3
Indirect Cost	94,035	24.7
Total before Contingency	$380,200	100.0

So far this discussion has dealt only with plants of one definite pattern. In the example used all equipment was steel with the exception of Admiralty tubes in the condenser and cooler. Also pressures did not exceed 175 psig. In the case of plants with considerable alloy or high pressure equipment the cost of equipment will constitute a larger fraction of total plant cost. Cost of foundations, platforms, buildings, insulation and electrical will be the same regardless of whether the equipment is steel or alloy or for low or high pressure. Therefore in estimating plants containing expensive alloy or high pressure equipment, multipliers must be adjusted downward to compensate. In our experience with petroleum refinery and petrochemical plants, process equipment rarely comprises less than 20 percent nor more than 40 percent of total battery limit cost. In most cases equipment represents between 25 and 35 percent of the total battery limit plant cost.

This discussion of the factor method of estimating battery limit costs of process units can be summarized by stating that the method is quite satisfactory as long as its use is restricted to evaluation studies. It is fast and therefore inexpensive. And by partially reducing estimating to a formula this method gives consistent answers when several alternative designs are being compared. Of course this type of estimate is not recommended as the basis of an appropriation for construction. The additional information required before preparation of construction drawings can be started also makes possible the preparation of a detailed estimate which can be much more accurate than any estimate based only on a flow sheet. However, when a quick estimate is needed and a process flow sheet is the only design available a factor type estimate is highly recommended.

LITERATURE CITED

[1] Lang, H. J., "Simplified Approach to Preliminary Cost Estimates," Chem. Eng., June, 1948.

[2] Rubin, F. L., "Heat Exchanger Costs Today," Chem. Eng., May, July, Sept., Oct., 1953.

Originally presented at the American Association of Cost Engineers meeting, Cleveland, June 16, 1958.

About the Author

William E. Hand is head of costing and appraisals for Shell Development Co., Emeryville, Calif. He is in charge of capital cost estimating for new processes. Hand received a degree in civil engineering from the University of Cincinnati. In 1928 he joined Berry Asphalt Co. as an engineer, and from 1929-1937 he was with Shell Petroleum Corp. as a chief draftsman and estimator. In 1938, he joined Shell Oil Co. at Wood River, Ill., as an office and utilities engineer. Hand has been with Shell Development Co. since 1941, at San Francisco and Emeryville.

Data Processing Systems Cut PM Costs

Update your preventive maintenance system by using data processing machines. The result will be better scheduling and improved labor predictions

By Jack Weinberger
Allstates Design & Development Co.
Trenton, N. J.

IS THERE any branch of the industry where PM doesn't pay? No. It is being applied to all types of operations, large and small, from bulk terminals to complete refinery and manufacturing facilities. One maintenance executive of a multiplant setup applies PM to his smallest operation of three men as well as to his larger plants of 250 men. There is no manpower limit, but the effective, well planned PM program will cut costs of maintenance work by reduction of manpower duplicating work on a haphazard, non-scheduled basis. PM works in process industries—either batch or continuous round-the-clock operations. It works on manufacturing production lines or continuous flow operations. None is exempt from its benefits. For management the YES of PM is in its over-all results of lower unit cost of manufacturing the product, better quality and lower capital investment needs. PM is an investment that needs extra cash as does any new plant or equipment. In the case of PM, the results are definite, tangible and on a constant return basis. For the plant supervisor and production man, the YES of PM is in production increases. Downtime of equipment is less with PM than the total outages of breakdown. In continuous-process departments, ALL units in that department (or on-line) are being serviced simultaneously, at a predetermined time rather than single units at separate breakdowns for a greater total of downtime. By close examination of records of PM in use now at other plants, the results have always spoken for themselves.

Anybody who expects to reap the full benefits of PM in a hurry will be disappointed. You will see tangible results and progress after several months. After that, it snowballs. All the experts agree it may take several years to put a large plant on a full PM program, but then, too, production goes on indefinitely in the meantime.

By removing its program from the jurisdiction of bookkeepers and employing electronic data processing machines. Allstates has developed the three-phase system which is as follows:

Phase 1. The purpose of this phase is the preparation of a comparative cost analysis from a survey of all equipment with regard to:

- The present maintenance procedures, plant standards and industrial practices, "rule of thumb" methods and past maintenance records.
- The latest available manufacturers' recommendations for maintenance of specified equipment.
- The integration of the two previous elements to establish standard maintenance requirements.
- The comparison of past maintenance methods with the new system and a cost analysis of both systems.

Phase 2. This phase encompasses the compilation of a master maintenance manual and master maintenance file. This manual will provide

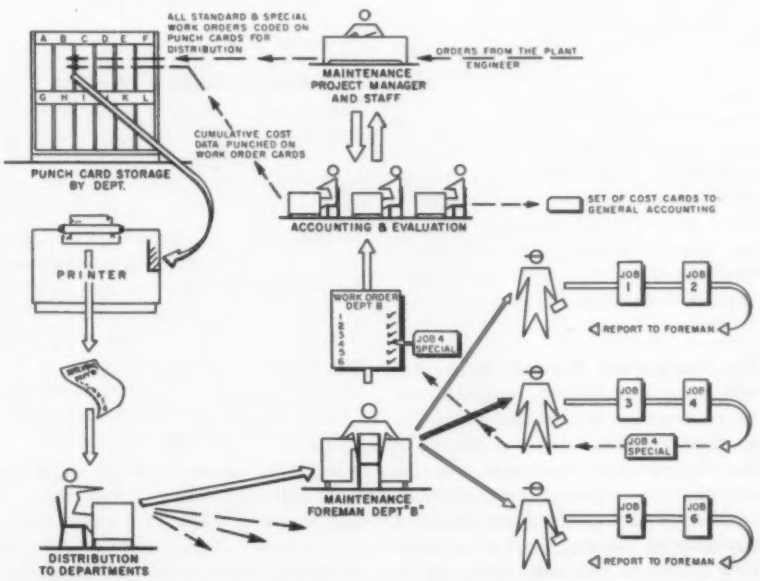


FIGURE 1—Punch card information flows through a Maintenance department easily.

the basic information for Phase 3 and will contain:

- All pertinent information concerning each item of equipment, i.e., type, location, function, maintenance history and responsibility.
- All references to source material in the master files, such as catalogs, drawings and instruction manuals or parts lists.
- All instructions pertaining to the repairs, service and rehabilitation of equipment together with any special information necessary.

Phase 3. The final phase will be devoted to segregating, coding and entering on punch cards, data obtained in Phases 1 and 2. These entries will include:

- All accounting information pertaining to total repair and rehabilitation costs, i.e., time, labor and materials shown as composite totals.
- All maintenance to be performed by either plant operators, plant repair personnel or outside contractor.
- All entries indicating regularly scheduled maintenance plus any emergency maintenance performed.

Upon completion of Phase 3, the program is given a trial or test run to determine the need for minor data or schedule revisions. When the system is operating satisfactorily, it then becomes necessary to formulate procedures for periodic review and revision by either a management group or a group designated to study the established procedures and recommend new maintenance practices. Once these stages are accomplished, the flow of information and corresponding performance of repair functions will parallel the organizational structure of Figure 1.

The Equipment Survey. Since this will be the preliminary stage of the entire program, it must be handled by a select group of men familiar with the most modern maintenance methods plus the years of experinece to cover the many standard practices and applications common to the industry. This group is generally made up of men responsible for the equipment undergoing study and they work in close alliance with the leaders of the maintenance groups now existing. Moreover, since this study group will formulate the future servicing requirements for this equipment, they must have access to all available information from the manufacturer of the equipment to provide the most complete basis possible on which to establish their standards for repair and rehabilitation functions and allocate the necessary labor and materials for each function.

The Cost Analysis. Upon completion of the equipment survey, a comparative cost analysis of the proposed system, as opposed to the former maintenance system, will provide management with a realistic basis on which to evaluate the relative value of both programs. This analysis will show distribution of labor, the frequency of repetitive functions, the incidence of emergency operations and the average cost per machine, plant-wide or according to department, depending upon the scope of the survey. Once these statistics are available to management, the actual savings in time and materials will be sharply defined as well as the predictable "trouble-spots" in any given department. Using this information as a basis, management can immediately re-orient the present maintenance structure to compensate for the most notable deficiencies.

The Maintenance Manual. The Maintenance Manual is to serve as the standardized source of information and procedure relating to the repair and rehabilitation of plant facilities. The information supplied through this medium will be compiled from the findings of the equipment survey and set forth in the light of practical economic considerations. However, only by continued revision based on the recommendations of the persons closely connected with the various functions can the fullest potential of this manual be realized.

Since the manual will serve as the basic reference for all maintenance and repair activities for plant facilities, it must, of necessity, contain all pertinent information pertaining to each specific piece of equipment. For example, the proper nomenclature, function, location, specifications and reference data such as bulletins and blueprints must be included in the segment of the manual devoted to each unit. In addition, a complete inventory of spare parts and auxiliary equipment for each unit must be included in this source.

For this purpose, 8½ by 11-inch, heavy card stock sheets have been found most acceptable. As stated, their function is to provide a complete and concise source of all information about one particular unit. Furthermore, since these sheets form the basis for establishing an automatic system of maintenance, they are limited in their contents to only what is absolutely essential to the optimum performance of the unit and, hence, stripped of all extraneous matter.

The maintenance instructions given by this manual will only be of a general nature because of the limitations upon space for descriptive purposes. However, in cases where more complete procedural instruction is necessary, the manual will refer to some other source of information available to the personnel responsible for this function. For example, should the manual call for the greasing of a conveyor in blank department during a certain period, the specific information as to the type of grease and number and position of grease fittings on the conveyor will be given in the form of a brief reference to a particular manual or pamphlet available in the files of the department where the conveyor is located.

Maintenance supervisors will be responsible for suggesting changes in the established method of performing a function. This may be done either upon newer recommendations from the manufacturer or studies in concert with personnel responsible for the maintenance and repair of the unit. In any case, the incorporation of the new procedure into the manual will depend upon the decision of higher management or a group set up to study the recommendations submitted.

Once a new method is adopted and included in the manual, it will require only a new set of instructions or reference data. A corresponding change in one punch card will assure that the new instructions will supersede any previous directions. This simple method of addendum will in no way

disrupt the regular maintenance schedule, since the whole operation requires only minutes to perform.

The maintenance manual, as outlined, will provide management with all current procedural information necessary for the efficient performance of their maintenance departments and will serve as a valuable source of instruction for all maintenance employees.

The Card Index System. The purpose of the Card Index System is to control the standard periodic maintenance procedures for machinery and equipment. To accomplish this objective, each set of pre-punched cards must contain the following basic information:

- Equipment name, number, and brief description
- Building and department number
- Maintenance responsibility (Individual or contractor)
- Reference to pages in Master Maintenace Manual for specific instructions.
- Coded reference to maintenance function required
- Date work is completed
- Time and materials cost
- All other unit cost information

Once the cards are punched for all equipment, they are sorted according to scheduled date, plant location and departmental responsibility. After being segregated, the information is printed on a Maintenance Report form which is distributed to the various department heads for study and assignment through work orders.

When the maintenance assignment is completed in the proper department, the work order is completed by the responsible maintenance supervisor and returned to the department supervisor for review. From the information thus provided, time and material charges are forwarded to accounting and plant engineering before the charge card is returned to its original department (see Figure 2).

In the event some departments are unable to complete allotted maintenance functions according to schedule, the work orders may be returned to the departmental supervisor for review and rescheduling. This factor, plus the frequency of unscheduled repairs, will provide management with a most reliable guide for estimating their allocations for manpower and work loads, since failure to comply

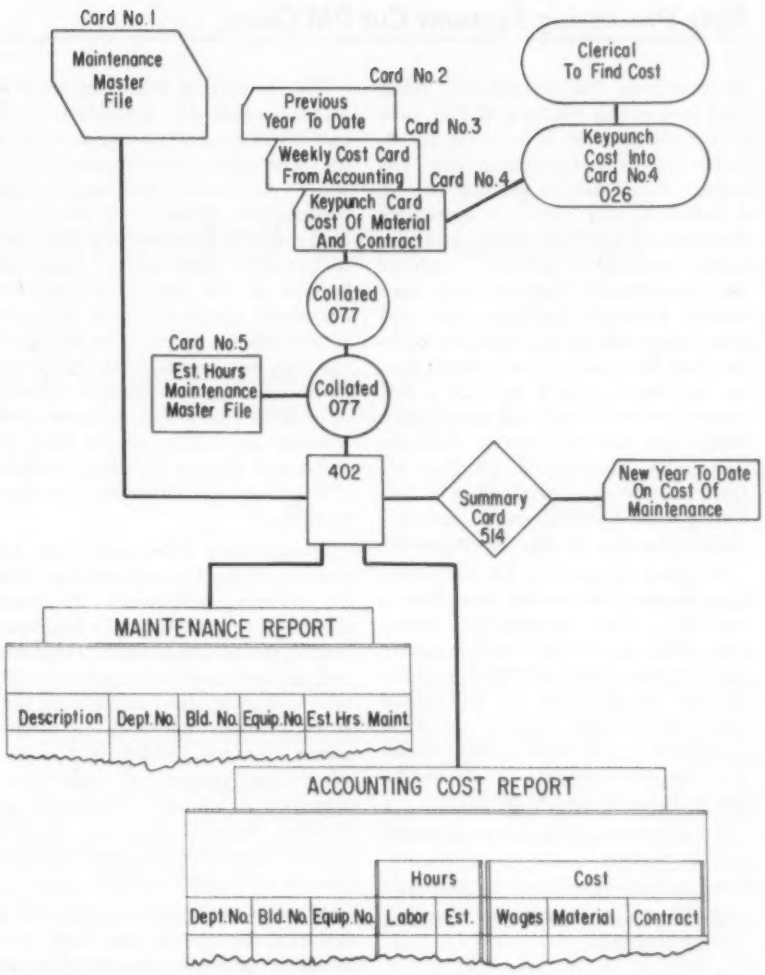


FIGURE 2—Time and material charge cards go to the Accounting and Maintenance department before returning to the file.

with the scheduled maintenance will specifically indicate deficiencies within a deparement that would not normally have been known to management. In addition, the responsibility and reasons for such deficiencies may be easly discovered through this system.

To assure the success of any preventive maintenance program resembling the one outlined in this article, the following problems must be considered:

- Will the company's present maintenance work-load permit sufficient time for employees to install this system?
- Will additional manpower be required for this work, and what additional training will they require?
- To what extent will the installation of this system disrupt existing maintenance programs or on stream time?
- To whom will go the overall responsibility for establishing and directing this system?
- What types of data processing machines will be needed and how many additional personnel will be needed to operate them?
- What will be the organizational structure and procedures governing this system?
- How can this program best be accomplished according to maintenance requirements and company policies?
- How will the estimated savings compare with the cost of installing this system?

Generally, at this point the maintenance executive finishes reading the above questions and throwing up his hands in dismay, turns his attention

to something less formidable. What with lack of this and lack of that, how in the wide world is he going to revamp an existing system that has taken x-long years to get working on a half-way basis? Well, Preventive Maintenance does work, and the highly systemized program, such as the punchcard method, does save money, increase productive time and most important of all, function without half the red-tape the systems now in use require. Let's look at a few statistics to see what other people have done. To satisfy itself, Allstates thoroughly investigated the past efforts of others in this field. The following case histories are a representative summary of that investigation:

A plant located in Euclid, Ohio, uses standard accounting machines to control a plant maintenance operation which covers two million square feet of plant area and 820 workmen. At the present time, 35 percent of their maintenance time is given to scheduled or preventive maintenance. The company reports the following results from its control program:

- Equipment breakdowns reduced 21 percent.
- Labor costs reduced 21 percent.
- Maintenance efficiency increased 38.9 percent.
- Decrease in yearly maintenance payroll over $210,000.
- Decrease in monthly replacement cost $38,000.

A steel company reports saving $50,000 during the first year of their maintenance program, which uses data processing equipment.

Through the installation of a maintenance control program using the card index or "tick-off" system, a Michigan brass company reports the following results after one year of operation:

- Maintenance efficiency increased 50 percent.
- Total maintenance costs decreased 50 percent.
- Yearly labor costs decreased $213,000.

A division of American Cyanamid Company reports an over-all decrease of 14 percent in maintenance costs for a period of one year using a card index system.

The preceding examples were selected because they best illustrate the two major control systems now in use for scheduling maintenance in advance. At present, two other systems are available. However, in the opinion of the writer, these are not applicable to extensive maintenance operations because in the case of the machine key sorter system the cost and speed of changes or revisions to the schedule does not compare favorably with corresponding alterations in punched or written cards. In the case of the manual key sorter system both the speed and ease of handling considerable amounts of information are questionable.

Despite their differences, these four systems all use basically similar forms for processing information. These are: the asset location card, equipment record, maintenance requirement card and maintenance cost report. The four programs also have a basic similarity in their approach to maintenance control, which is based on scheduling "preventive" maintenance operation in advance. The major differences between them lie in their relative capacities for handling information easily and rapidly.

A somewhat different approach to maintenance control has been made by firms primarily interested in improving personnel efficiency through analysis and evaluation of each maintenance operation. This approach has been variously designated as "work measurement", "work simplification", "work evaluation" or "work sampling". Nevertheless, all such systems are essentially the same in their methods and application.

Although the "work measurement" approach has undeniable merits, the "preventive maintenance" scheduling system was chosen by Allstates to develop for the present because it is believed to be the more practical and economic approach for the majority of plants. Virtually all petroleum, petrochemical and chemical plants in operation today have some form of maintenance program in action, whether it is on a scheduled or "preventive" basis or not. Furthermore, since "measurement" belongs to the field of time study and analysis, it is believed it should only follow in the footsteps of a properly organized maintenance control program, which would then make parts control, job standardization and other subsequent programs more practical.

It can also be pointed out that the reasons for choosing the "preventive" approach to maintenance control are based upon the proven value of this system in initiating realistic maintenance control measures. Existing maintenance programs can readily be adapted to a systemized method of card-index programing by integration of maintenance work forces to correlate with the programing of future schedules. As the basis of this method is establishment of past histories of equipment together with present practices, the work-up of future schedules is a combination of past performance, plus present work needs to yield anticipated future requirement. Economically this places the supervisory forces in better position to budget the maintenance dollar structure for as many periods of working time in advance as may be required for scheduled downtime periods.

ACKNOWLEDGMENT

The author wishes to thank the management of Allstates Design and Development Company, Inc., for permission to publish the above account and gratefully acknowledge the assistance of George M. Pruitt, Trenton division manager, and all others who cooperated in its preparation.

BIBLIOGRAPHY

L. C. Morrow, Editor, Maintenance Engineering Handbook, Chapter 8. Cpyright 1957 by McGraw-Hill Book Company, Inc.

About the Author

Jack Weinberger is a project engineer in the Petroleum and Chemical section of Allstates Design and Development Co., Inc., Trenton, N.J. A native of New York, he received his B.S. degree in marine engineering from the U.S. Merchant Marine Academy. While working for Catalytic Construction Co. he attended Pennsylvania State College, taking mineral industries extension courses in night sessions, and received his B.S. degree in refinery engineering in 1954. He has held his present position at Allstate since 1955.

Lower maintenance costs using . . .

Suggested Practices for Unit Layout

Esso's studies reveal how to lay out a refining unit for minimum turnaround costs in the shortest time with the least manpower

J. V. Marancik
Esso Research and Engineering Company
Linden, N. J.

ENGINEERS ARE placing increasing emphasis on facilities for minimizing maintenance costs as one of the most important features of refinery unit design. Because of the complexity of a modern refinery unit and the high investment involved, it is imperative that units be kept in operation for maximum periods and that downtime and maintenance costs be reduced to the minimum consideration.

Aside from the process design aspects, no single factor is as important as the physical layout of the equipment itself. A modern refinery unit erected today is likely to remain in use for 20 or more years and any errors in the beginning may be costly, if not impossible, to rectify later.

Unit Layout. Unit layout, maintenance, and the efficient use of manpower required to operate and service a modern refinery have been the subject of careful study and periodic review by Esso Engineers together with the Mechanical, Operating, and Safety departments of the various company affiliates. The objective of these studies has been to establish layout and design practices which would allow a unit to be turned around at least cost and in the shortest possible time with minimum manpower. As a result of the studies, the following basic principles have been adopted for unit layout:

- Utilizing mobile equipment to the maximum possible extent.
- Reducing built-in handling facilities to a bare minimum.

The importance of reducing maintenance cost is strongly emphasized when it is realized how large a portion of the refinery payroll is consumed in keeping refinery facilities at peak performance. This cost alone may run up to 20 percent of the total refinery operating costs and as many as 40 to 50 percent of all refinery employes may be engaged in some phase of related mechanical or maintenance work.

Designing a unit for the application of mobile equipment requires that equipment shall be laid out "horizontally," or as close to ground level as dictated by the reach of the mobile equipment, and with provision for working space and accessways for passage of equipment within the battery limits. Equipment requiring operator attention such as control valves and instruments, are located at grade, or as close thereto as possible, for operating convenience. This serves to expedite turn-around work. The units are designed with as little structural steel as possible to permit quick ac-

TABLE 1—Recommended Clearances Between Operating Unit Equipment Items

The following distances apply to general groups of process units—those that can be considered to handle light ends products and those that handle heavier products.

Equipment Designation	Light Ends Units	Atmospheric Distillation Units
1. Distance from shell of towers, drums, exchangers, and pipe bands to edge of furnaces	50 ft. (1)	40 ft.
2. Distance between groups of pumps and edge of furnaces	75 ft. (2)	40 ft. (2)
3. Clear distance from towers and drums to pumps except where bad suction conditions exist or for individual ungrouped pumps	15 ft. min.	10 ft. min.
4. Distance between pressurized unit substations and pieces of equipment (not including furnaces)	50 ft. min.	50 ft. min.
5. Distances between pumps and exchangers	15 ft. min. (3)	10 ft. min. (3)
6. Distance between control houses and unit structures	50 ft.	40 ft.
7. Distance between control houses and unit furnaces	50 ft.	40 ft.
8. Distance between pressure storage vessels and nearest piece of refinery equipment (such as storage process raw materials at the unit site, i.e., propane or hydrogen storage vessels but not including condensate receiving drums)	75 ft. min. (always unit boundary and furthest from furnace).	

(1) May be reduced where required for process reasons as for reactors in catalytic reforming units.
(2) Pumps preferably located at opposite side of fractionation equipment away from furnaces.
(3) Where large cranes are used for maintenance, these distances should be a minimum of 25 feet.

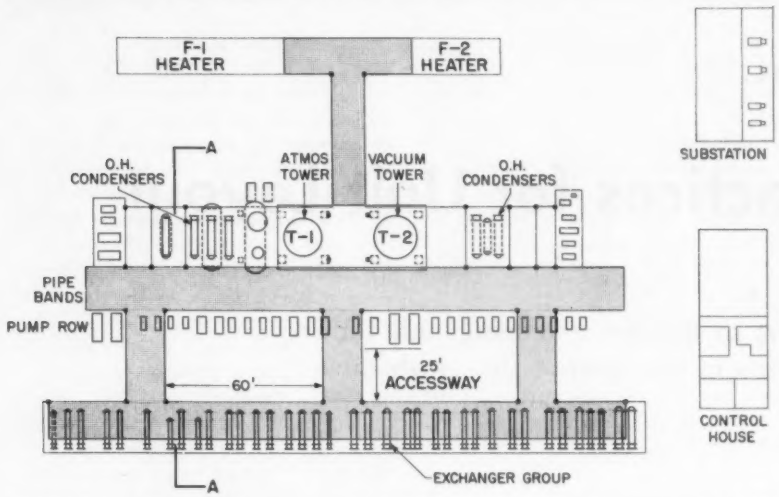


FIGURE 1—"Grouped" layout of a 65,000 B/D atmospheric and vacuum pipe still. Note lack of congestion in piping or structure permitting cranes to approach close to unit at all points.

cess to the process equipment. In former so called compact designs, equipment was arranged "vertically" with close spacing requiring greater need for platforms, ladders, stairways, permanent trolleys, hoists, and supporting structural steel.

In some instances, it may be found that greater area is required for layouts utilizing mobile maintenance equipment. This may be so where internal accessways are required, or where individual pieces of equipment need greater space for accessibility. In the case of smaller units, however, access can usually be provided around the perimeter.

The cost of a mobile design layout may be slightly greater than the more compact layout. However, the slightly greater first cost is more than made up for in the recurring savings in longer unit on-stream times and the reduction in permanent manpower made possible by the ue of mechanization, and the greater safety provided by the added unit area. A most important advantage is the fact that nearly all the company's safety spacing requirements are automatically met when designing for maintenance with mobile equipment.

Table 1 serves as a guide to be followed in laying out units permitting the general use of mobile equipment. These spacings meet the requirements of the mechanical and maintenance forces and the distances required by the safety divisions. Departure from the suggested spacings are made only after a thorough review with all interested departments.

Mobile Equipment. Improvements in the design of mobile equipment, and the development of handling techniques by the refineries themselves, have directed the layout of units away from the use of built-in equipment.

Advantages are offered in the use of mobile equipment by (a) the flexibility permitted in application for multiple uses, limted only by the experience and ingenuity of the operators, and (b) its possibilities in maintaining a high mobile equipment use factor. In large refineries, of course, a very high use factor can be maintained on equipment owned. In smaller refineries, where the unit layouts also follow spacings and design practices for use of mobile maintenance equipment, it may be possible to subcontract or rent equipment for maintenance over the turnaround periods.

The disadvantage of built-in equipment is its low use factor. It may be used as little as one day per year and remain idle for the greater portion of its life, representing a high investment cost and, in addition, is another item requiring maintenance. There are numerous instances where hoists failed to operate after long periods of idleness, requiring time for repair when needed most. The additional ladders and platforms and structure supporting built-in equipment are items also requiring the same maintenance as the process equipment itself.

While built-in handling facilities have been replaced in many instances, there still remain a few areas where trolleys or bridge cranes must be used. Typical applications are for servicing reciprocating or centrifugal compressors located in compressor buildings, and for handling safety valves or trays at high levels.

The major mobile equipment utilized consists of high capacity cranes with booms up to 80-foot length, smaller cranes to operate under 17-foot head room; lift and straddle trucks, dumpsters, etc. By using all the mobile facilities available, tube bundles, valves, etc., can be dispatched to the central shops for repair. Thus, valuable turnaround time and manpower may be conserved by taking the work to the shops rather than transporting additional men and tools to the job site.

The use of power tools in connection with mobile equipment has reduced to the minimum the number of men used during a turnaround

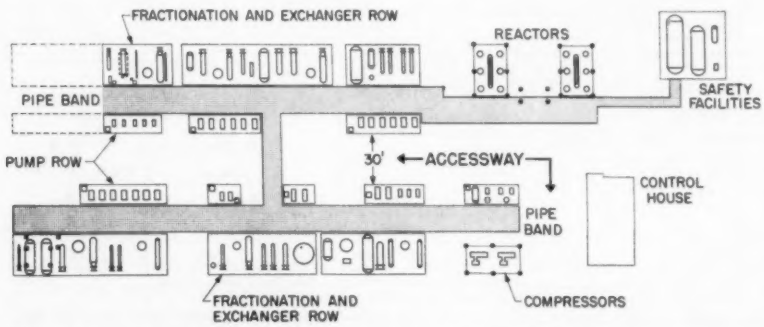


FIGURE 2—"Flow line" pattern of a complex light ends unit. Layout shows how space can be saved by using a common accessway for parallel equipment banks.

and shortened the turnaround period. The resulting increase in unit service factor can be directly evaluated in increased refinery throughput.

In some of the larger refineries, there may be 20 or more cranes of various sizes in operation for maintenance or on new construction work. The majority of these are refinery owned and are supplemented by rented cranes during periods of peak demand.

Unit Layout Procedure. Units can usually be placed in one of two general forms. One is the "grouped layout" where similar equipment such as towers, pumps, exchangers, etc., are grouped together in separate areas to facilitate operation and maintenance. The other is the "flow line" pattern where towers, pumps, exchangers, etc., are arranged in the layout as they appear on the flow plan.

The "grouped layout" applied for larger units with a large number of pumps, exchangers and drums. The "flow line" pattern is particularly applicable to small units or to large units where there are relatively few pumps or exchangers.

Figures 1 and 2 are practical examples of the two types of layout arrangement, each following the spacings given in Table 1. Figures 1 and 3 are, respectively, a plot plan and a cross-section through a 65,000-bpd pipe still employing the grouped principles. Figure 2 is a plot plan of a light ends specialty plant using the flow line pattern. In this case, space is saved by placing the equipment in two parallel rows with a common 30-foot wide accessway between them.

Both of these units show the spacing practices as given in Table 1. There are instances, of course, where the spacings may be modified for safety, operational or maintenance reasons. A few examples are as follows:

- Pumps may be placed closer than the 15-feet permitted in Table 1 where sufficient suction head is not available or where heavy viscous materials are handled.

- In a Powerformer unit, the reactors may be located closer to furnaces than called for in Table 1. In this case process reasons require minimum residence time in the transfer line between the furnace and reactors to reduce thermal cracking. The shorter distance is important since these lines operate at high temperature, may require the use of expensive alloys, and also because of the expansion problems involved in designing the transfer lines. It is further justified because of the comparatively small amount of liquid hold-up in this part of the system.

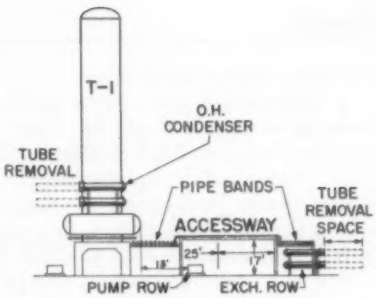


FIGURE 3—Section AA through Figure 1, showing accessibility for mobile equipment within the unit and along the perimeter.

Figures 1 to 3 show a large number of exchangers located as close to grade as possible. Figures 1 and 3 note a minimum of overhead obstruction which might interfere with free operation of cranes. The pipe bands at the pump row offer minimum interference with removal of pumps. The exchanger channel end extends beyond the pipe band above it, permitting handling of the channel end and tube bundles by mobile equipment. This feature is desirable also at the shell cover end of the exchangers, but could not be accomplished in this case due to the large number of pipe lines required in the pipe band. It will be noted in Figures 1 and 3 that there is a minimum of structural steel or built-in facilities in these units.

In both the "grouped" and "flow line" layout arrangements, the equipment is essentially placed in no more than two adjacent rows. By limiting the equipment layout to such a double row arrangement, the mobile equipment can approach very close to at least one side of any tower structure, pump or exchanger row. Accessways should be at least 25 feet in width to permit a large crane to operate with complete freedom. This area should be clear of overhead piping or other obstruction. The 25-foot dimension also allows for unhindered two way passage of trucks which is very important during the short turnaround periods. Where 2 or more pipe bands cross accessways, there should be a minimum clear space of 60 feet between to raise or lower a crane boom.

In Figures 1 and 3 it will be seen that a crane standing in the 25-foot accessway between the pumps and exchangers can be used to reach over the pipe bands to higher levels of the tower row. The space between the heaters and towers permits a crane to work on any part of the furnace, including furnace tube removal, and to reach the overhead exchangers, piping, etc., at the tower row.

Recommended Design Practices

Following are the more important items which must be considered in designing for units to be maintained by mobile equipment.

General Practices

1. Locate exchangers and other equipment at grade where possible.

2. Locate all control valves at lowest possible level, preferably at grade for operator convenience and for maintenance accessibility.

3. Exchangers, if stacked, should be no more than two high, piping permitting, and not higher than 12 feet for smaller size exchangers.

4. Utilize large cranes to serve overhead condensers located at elevations up to 50 feet. Above 50 feet use permanent trolley and hoist.

5. Utilize cranes up to 80 feet elevation for removing valves, fittings, pipe and light weight equipment.

6. Provide davits on top of towers to handle safety valves and for handling tower trays. Provide drop-out space for removing trays. Provide davits on all manhead covers.

7. Use flooded type condensers and coolers located at grade in place of overhead condensers and coolers where the operating pressures are high enough to permit this type of installation.

8. Where fouling may occur in overhead condenser service, install valves on each half of condenser group to permit insitu chemical cleaning or tube bundle removal during operation of the unit.

9. On fouling exchangers located at grade provide bypass or valving, to permit removal of tube bundle during operation of the unit.

10. Avoid locating exchangers under drums or under unit structure. Where so located of necessity, the channel end should be clear of over-

head obstructions for handling of channel end by small cranes.

11. Where exchangers are stacked two high, provide lifting lugs at 45 degrees on each side of the lower exchanger channel end.

12. Avoid vertical exchangers in all cases unless required for process reasons.

Piping.

1. Locate pipe bands where they offer least interference with access to equipment which may require maintenance. Allow clear space above pumps and exchangers. Figure 3 shows a typical cross-section of a unit showing piping with 15 foot minimum horizontal clearance required for safety.

Pipe bands must, of necessity, be located above grouped exchangers. Where so required, be sure the channel and rear heads, if possible, are clear of pipe runs to permit handling of covers.

2. Where piping between pumps and exchangers cross accessways the piping should be grouped in pipe bands at a minimum of approximately 60 feet intervals to permit raising crane booms.

3. Locate control and main operating valves as close to grade as possible for both operating convenience and maintenance accessibility.

4. Minimum height of pipe bands crossing accessways should be 17 feet. At other locations 7 feet minimum.

5. Provide sufficient piping flexibility at pump suction and discharge connections to relieve force due to thermal expansion.

6. Design pipe supports at pumps to prevent piping stresses on pump nozzles and casings and to avoid need for temporary support during pump removal.

7. Lines on supports should have line contact with supporting steel. Usually a ¾ Ø bar welded to the top of the supporting member will elevate the line sufficiently high to minimize corrosion and permit inspection and painting.

8. Lines located at grade should be placed on sleepers.

9. Avoid underground process piping. Where required because of suction conditions such as feed pumps, line should be wrapped and placed in a sand-filled trench.

10. Insulated lines should have tee section supports to raise piping above support beam and to facilitate application of insulation.

11. Where other wise inaccessible flanges must be uncoupled for isolation of equipment during turnaround, such as at furnace inlet and outlet connections, provide permanent platform. Minimize need for temporary scaffolding.

Pumps And Compressors. Pumps in oil service are located outdoors in practically all cases. Where the possibility of freezing exists, steam tracing or electric heating plus insulation will give the required protection. This has been successful in temperatures as low as —40 F. Water pumps located at remote locations are protected by steam or electric tracing.

Both reciprocating and centrifugal compressors are used in many refinery units with centrifugals being used more often, especially in the larger sizes. In quite a few installations a single centrifugal compressor is used without provision for a spare because of the high service factor of this equipment. It is, therefore, important that they be installed to permit dismantling and reassembly in the shortest possible time. Turnaround time is reduced by using compressors with bottom suction and discharge connections. Compressor repair, when involving removal of especially large diameter piping, can be an item requiring very long repair time during a turnaround. The machines are placed on platforms elevated 8 feet above grade with all piping connections being made at the underside. The split rotor casing permits the removal of the top cover exposing the internals of the machine with a minimum of dismantling of attached piping connections. While this design is more costly than in the case of the top suction and discharge design, the saving in downtime can be directly evaluated, especially during the breaking in period at initial unit startup.

Both the centrifugal and reciprocating compressors are usually located under a shelter because of the nature of work required in servicing them. Smaller compressors have been treated in the same manner as pumps and have been located out-doors in the pump row. The compressor shelter usually consists of a steel frame structure covered with corrugated siding. The lower 8-foot portion of the shelter is left open on all four sides to provide maximum ventilation. The 8-foot portion can be covered with a canvas curtain to be used during inclement weather at turnaround time.

Paving And Toe Walls. The extent of, and need for, paving is usually determined by the nature of the soil conditions. Paving is placed around pumps, exchangers, towers, drums, etc., where oil spills may occur during operation or turnaround. Accessways and area where mobile equipment may operate may be surfaced with crushed stone or be paved. It has been found that areas paved with crushed stone require resurfacing after each turnaround.

Toe walls are required for safety reasons around pumps, exchangers, or where the volume contained in a single vessel is more than 1,000 gallons. While necessary from the safety view point, toe walls do not permit mobile equipment to approach as close to pumps and exchangers as is desired by the maintenance forces. In some instances toe walls are omitted when other safety precautions are followed. This may consist of providing additional catch basins and also providing greater slope in the paving for surface drainage and oil spills. ##

About the Author

Joseph V. Marancik is with Esso Research and Engineering Co., where he is now on special assignment as a consultant on refinery design and layout matters. He has been with Esso for 38 years, and was at one time head of the Project Group, the function of which was, among other things, to secure and develop design data needed to build chemical plants and refineries. He has worked with soil mechanics, structural design, piping systems, sewers and separators, and other refinery facilities. Marancik was a member of the first catalytic cracking committee which developed the fluid cracking process. He studied engineering at Brooklyn Polytechnic Institute and Columbia University

If you're building, take a look at . . .

Why Prestressed Concrete Cuts Costs

By introducing artificial stresses through tensioning the reinforcing steel, you'll save material and have slender, pleasing structures

John Makaretz
Badger Manufacturing Company, Cambridge, Mass.

LINEAR PRESTRESSED concrete was introduced in the U. S. approximately ten years ago and has been used primarily in bridge construction. Recently, prestressing has found application in forming a variety of structural members for building construction.

"Prestressing" concrete means introducing artificial stresses in the concrete by means of tensioned reinforcing steel. These stresses are of such nature and magnitude that under actual load the stresses will be counterbalanced. The concrete section will normally remain in compression but under special conditons some tension is permitted. The ideal use of prestressed concrete produces not only material savings, but also structures having a slender, pleasing appearance.

The economic and technical value of this versatile structural material has rapidly proven itself in this country. In 1950, the U. S. had almost no prestressing plants; today there are well over 200. The increase is due partly to the structural steel shortage which occurred in the summer of 1956. The overall effect has been felt in both public and private construction in all degree of size.

Low initial cost, speed of construction, minimum maintenance and good appearance are common reasons for using precast, prestressed concrete structural members. Fabricating can be done at the precasting plant, and the contractor can transport and erect the members as he would structural steel.

Reinforcing steel bars with yield stress of 40,000 pounds per square inch cost about $0.11 per pound compared to $0.45 for high tension steel for post-tensioning and $0.30 per pound for pretensioning steel based on yield stress of 200,000 psi. The strength relation of reinforcing steel to high tension steel is 1:5. The cost relation of reinforcing steel is about 1:4.5 for post-tensioning steel and 1:3 for pretensioning steel. Relative costs are at present changing, however, in favor of post-tensioning steel.

As with every construction material, prestressed concrete also has its limitations. For example, not enough is known about the behavior of prestressed members exposed to prolonged high temperatures (300 F.-1000 F.). According to German Bulletin No. 122, "Deutscher Auschuss for Stahlbeton," in relatively moderate temperature (380 F.-580 F.) the prestressed member loses its prestressing and becomes an ordinary concrete member with highly stressed, untensioned reinforcement.

To avoid heat damage, prestressed steel should have a substantial insulating cover or an additional layer of fire-resistant material. It is believed that in fire hazardous areas, use of conventional reinforcing concrete or, in some cases, fire-proofed steel is more economical and technically more sound.

To develop specific information in this area, the Prestressed Concrete Institute has engaged the Underwriter's Laboratory to conduct comprehensive fire tests of prestressed concrete units. The results are to be announced in the near future.

An important economic factor governing the use of prestressed members is repetition or standardization. Prestressed members are most economical where standard sizes can be used, or where adequate repetition occurs to justify special sizes. Another consideration is the nearness of the precasting plant to the construction site.

The technical acceptance of prestressed concrete, and the increased number of facilities for precasting, will undoubtedly encourage engineers and contractors to use prestressed concrete to an increasing extent in applications where structural steel or reinforced concrete is now used.

In the petroleum industry, the most significant application of prestressed concrete has been in construction of off-shore production and drilling platforms (Lake Maracaibo, Venezuela) and precast, prestressed oil storage facilities (Gulf of Mexico). Prestressed pipes are also used as oil well conductors.

This article will attempt to show where prestressed concrete can have

Why Prestressed Concrete Cuts Costs . . .

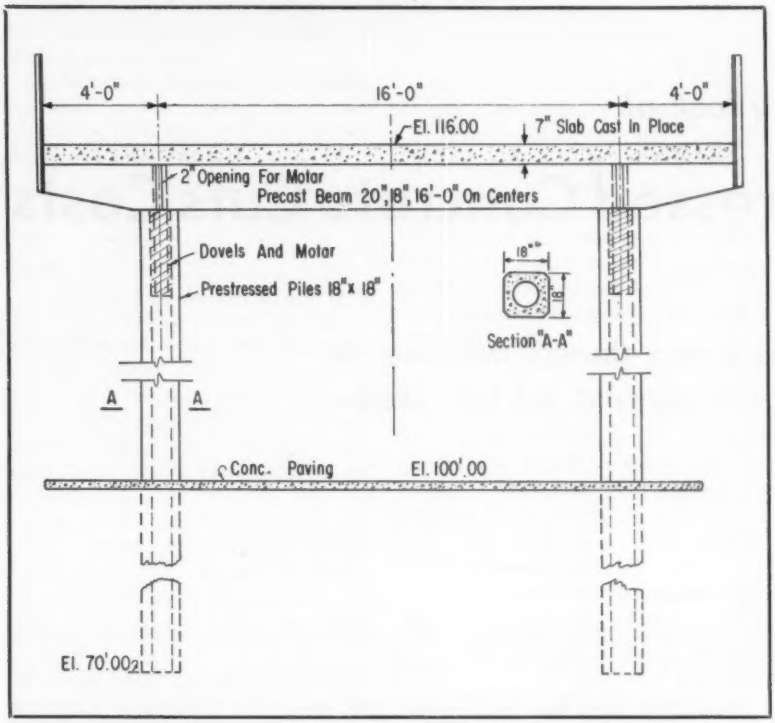


FIGURE 1—Prestressed concrete piles can save $1.25 per foot over steel piles.

About the Author

Makaretz

John Makaretz, a structural engineer for Badger Manufacturing Co., has had wide experience with concrete in building dams, bridges, and in heavy industrial construction. After obtaining a M.S. degree in engineering from the Lwow Institute of Technology in Poland, he practiced structural engineering in Europe for several years. Before joining Badger, he was chief structural engineer with Thomas Worcester Co., Boston. During this time he was in charge of designing the new prestressed concrete bridge spanning the Connecticut River at Hartford, Makaretz is a member of the Prestressed Concrete Institute.

further practical and economical applications in the construction of refineries and petrochemical plants.

Foundations. Under towers and heavy equipment, prestressed concrete piles can be used economically where longer piles are required (over 60 feet). Such piles can be used as point bearing or friction piles and have the combined qualities of precast concrete and steel piles. The absence of cracks in prestressed concrete piles gives them high resilience and desirable driving characteristics. A 14 inch x 14 inch precast concrete pile, prestressed with 12⅝-inch strands, can carry about 70 tons. Prestressed piles can be delivered to the construction site for about $4.25 per lineal foot compared to $5.80 (delivered) for steel piles of the same length and bearing capacity. Figure 1 shows a special application of the hollow core pile.

Piles are driven to the required depth, with their upper ends protruding to the necessary elevation above finished ground. Precast concrete beams with extended hollow-core dowels can be placed on top of the piles, the cores then filled with concrete. A concrete slab can be cast in place on the beams. Such structures are used for support of any elevated equipment.

As outlined above, a structure using prestressed concrete hollow piles sunk 30 feet in the ground, a precast reinforced concrete beam 20 inches x 18 inches, and a cast-in-place 7-inch slab designed for 200 pounds per square foot live load would cost about $5.50 per square foot. Using conventional materials (piles, pile capping and columns), the structure would cost about $7.25 per square foot.

Foundations under towers and other mat foundations for heavy equipment can be post-tensioned in both directions by placing flexible metal tubes in the forms before the concrete is cast (Figure 2). The high tension steel supplies the tensile force F, and the concrete the compressive force C. The a value represents the arm between the center of compression and the prestressing force; e represents the eccentricity of compressive force. Dimension d (mat thickness) can be decreased

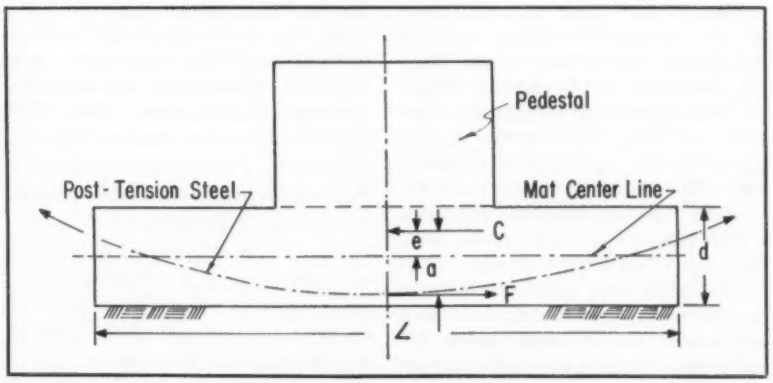


FIGURE 2—Placing flexible metal tubes in the forms before pouring concrete allows a tower foundation to be post-tensioned.

about 30 percent in comparison to regular reinforced concrete.

Concrete used for mats would be 5000 psi, twice as strong as ordinary foundation concrete and only 15 to 20 percent more expensive. Steel used for post-tensioning is five times as strong as ordinary reinforcing steel but only 3½ to 4 times as expensive, including the necessary tubing and anchorage, Post-tensioning the mat would result in over-all savings of about 25 percent in comparison with conventional construction.

Pipe Supports. For yard supports, precast, prestressed beams of constant cross sections can be used economically in combination with precast, prestressed square or cast in place concrete columns.

Beams should be designed for maximum expected pipe load and prestressed at the precasting plant in lengths up to 350 feet subdivided into required sections. Assembly of the separate members at the site can be done on the ground and erected as one unit (Figure 3).

Cost of the illustrated pipe support frame, rated at 50 pounds per square foot live load, would be about $130 per cubic yard for concrete for the prestressed beams and about $165 per cubic yard for the regular reinforced columns.

For low supported pipes, where bridges are required, a precast, prestressed concrete hollow slab member can be economically used for spans up to about 30 feet.

One square foot of the prestressed superstructure would cost about $4.50 per square foot in place, with support and black-top not included (Figure 4).

Buildings. There is little repetition in the structural members used for buildings in the petroleum industry. However, some maintenance buildings and warehouses can be built of a combination of precast conventional concrete and prestressed concrete. Prestressed double-tee sections can be used for the roofs. On control houses for spans up to 60 feet, one square foot of the double-tee deck in place will cost about $1.50. Freedom from interior partitions is one of the advantages of using long span prestressed roof panel.

If desired, the whole control house can be built of precast reinforced concrete columns and beams, prefabricated panels, and glass. Precast reinforced concrete columns in place cost about $150 per cubic yard of concrete.

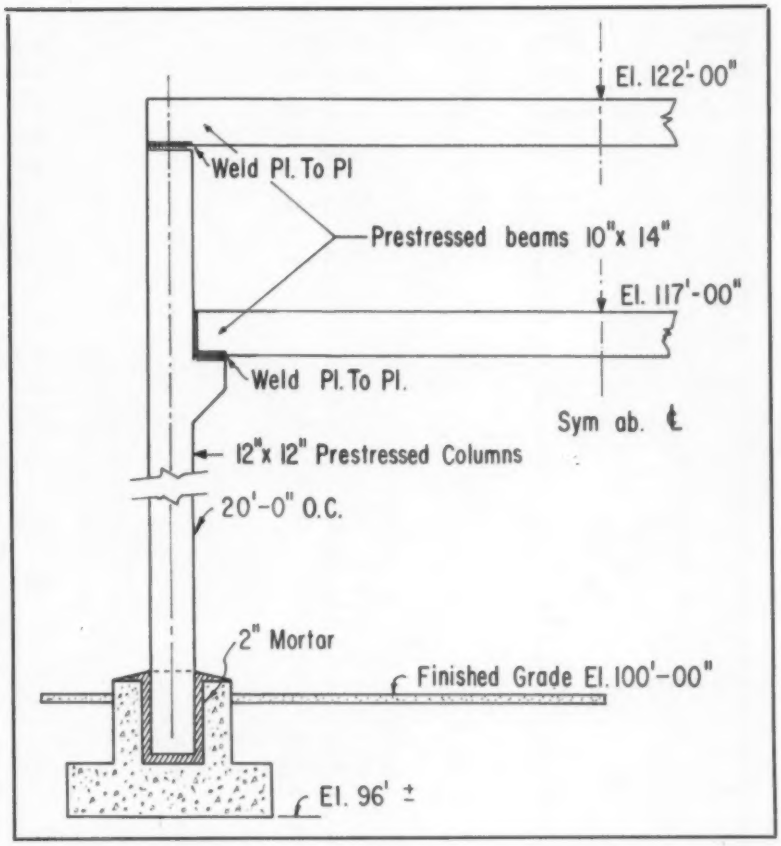


FIGURE 3—Pipe supports can be assembled on the ground and erected as one unit.

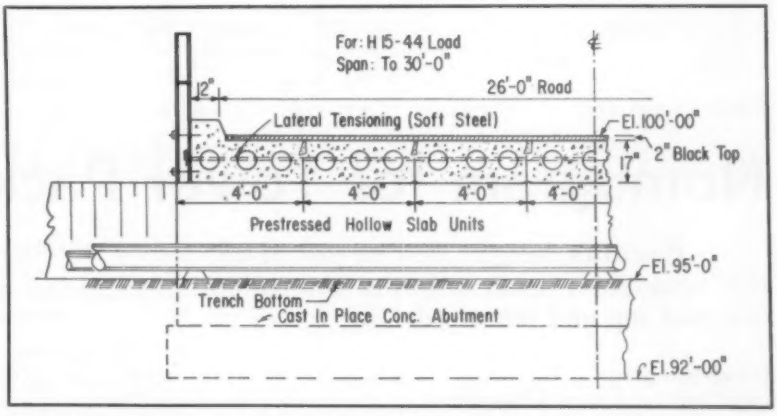


FIGURE 4—For pipes in a trench, prestressed concrete hollow slab units are ideal for bridge spans up to 30 feet.

In general, the designer should keep in mind that prestressed concrete has limitations and will never eliminate regular reinforced concrete and structural steel. Further, increased yield point for the reinforcing steel in conventional concrete will present a new competitive factor for prestressed members. It is up to the designing engineer to decide which materials will be most suitable for specific projects after all factors have been taken into consideration.

BIBLIOGRAPHY

[1] T. Y. Lin: "Prestressed Concrete Structures"
[2] Prestressed Concrete Institute: P. C. items
[3] Journal of the American Concrete Institute

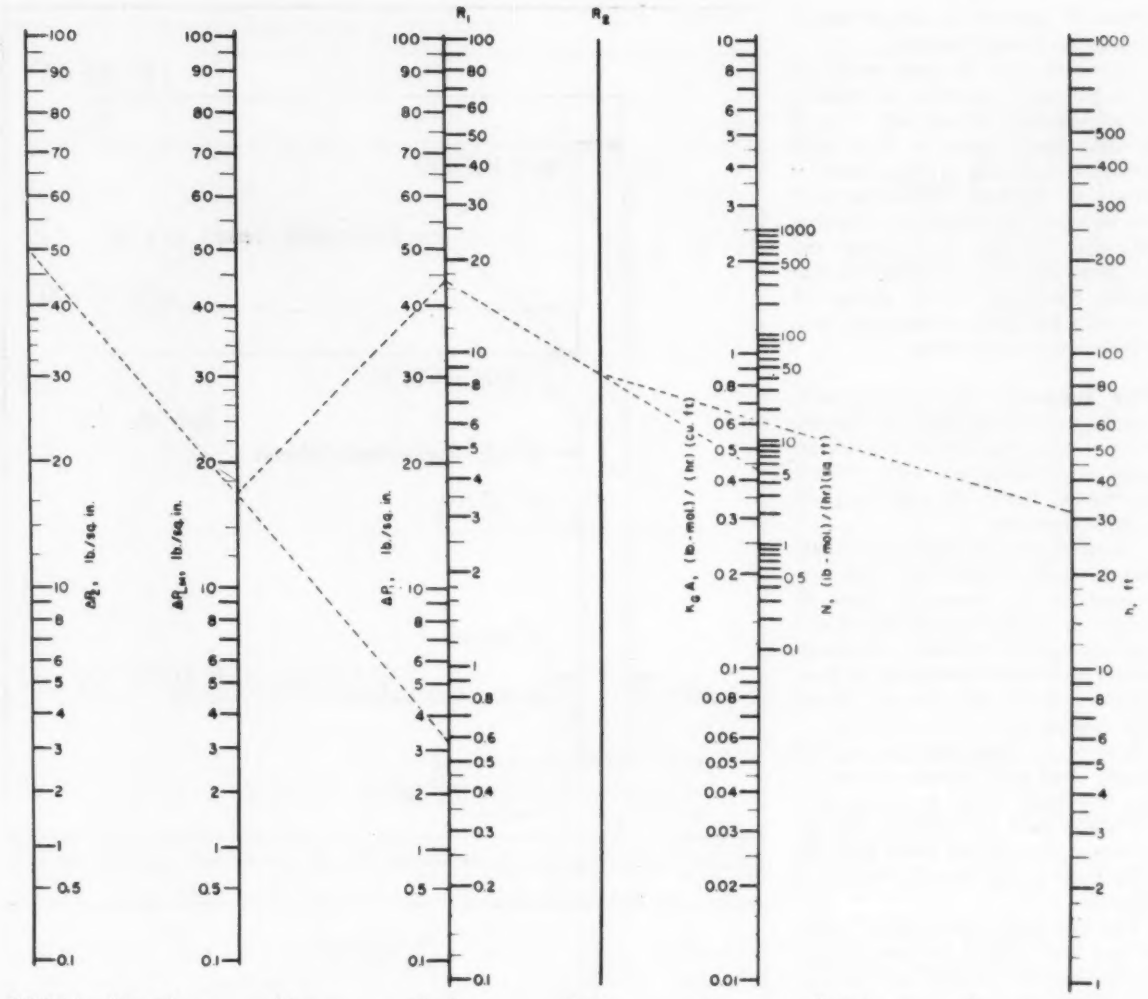


FIGURE 1—Key: ΔP_1 ..... ΔP_{LM} ..... ΔP_2; P_{LM} ..... R_1; R_1 ..... R_2 ..... K_GA; R_2 ..... N ..... h.

Nomogram for Tower Packing Height

Packing height can be picked-off this nomogram using only the absorption rate and top and bottom driving forces

Liang-tseng Fan,
Department of Chemical Engineering
Kansas State College, Manhattan, Kansas

IN SPITE OF RECENT theoretical developments, the capacities of packed absorption towers, both commercial and pilot plant scales, are often represented by the empirical quantity, K_GA (over-all mass transfer coefficient: (lb.-mol.)/(hr.)(cu.ft.)(atm.)) calculated by the following equation, especially when absorption is accompanied by chemical reaction.[1,2]

$$K_GA = \frac{N}{\dfrac{h\,\Delta P_2 - \Delta P_1}{\ln \dfrac{\Delta P_2}{\Delta P_1}}}$$

where N = rate of absorption, lb.-mol./(hr.)(sq.ft.)
h = height of packing, ft.
ΔP_2 = driving force at bottom of packing, atm.
ΔP_1 = driving force at top of packing, atm.

This equation has also been used for calculation of tower scale-up from available data.

The use of a nomogram representing the above equation is illustrated by the following example, in which commercial data are used.

Example: N = 16.6 lb.-mol./(hr.)(ft.^{2})
K_GA = 0.429 lb.-mol./(hr.)(cu.ft.)(atm.)
ΔP_2 = 49.7 lb./sq.in.
ΔP_1 = 3.3 lb./sq.in.
h = 32 ft.

In the nomogram, instead of using atmospheres, as in the equation, the scales of driving forces are in the unit of lb./sq.in. which is used more frequently in practice.

LITERATURE CITED

[1] Benson, H. E., *et al.*, Chem. Eng. Prog., 50, 356 (1954).
[2] Leva, M., "Tower Packings and Packed Tower Design," 2nd ed., p. 108, U. S. Stoneware, Akron (1953).

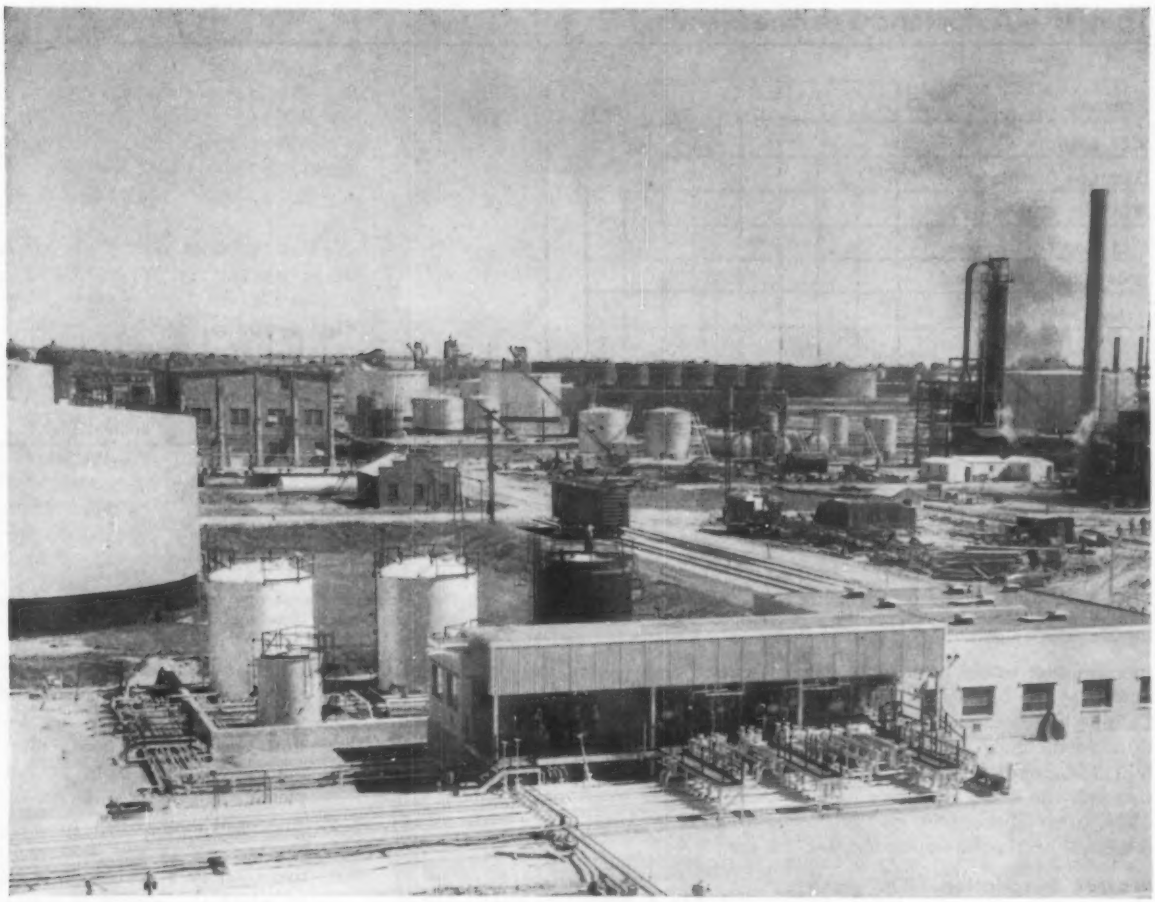


FIGURE 1—The blending system provides a continuous flow of an on-specification product. The headers are shown in the foreground. The additives and TEL are stored near the blender to consolidate the operation.

They Use Automatic Gasoline Blending

Sohio will make their gasoline with a continuous in-line blending system. Now finished product storage is not required

H. D. Applequist
The Standard Oil Company (Ohio), Cleveland
James E. Krebs
The M. W. Kellogg Company, New York City

OF MAJOR CONCERN to every refiner is the ability to meet a specified product requirement at minimum cost within a specified period of time. The Standard Oil Company of Ohio, considering these requirements in view of new refining facilities at Toledo, contracted with The M. W. Kellogg Company for the design and construction of a "continuous in-line gasoline blending system." The system was to be designed to blend any gasoline at rates ranging from 40,000 to 80,000 bpd.

Sohio based the selection of a "continuous in-line gasoline blender" upon an economic study of various blending methods currently in use which could be incorporated into an existing refinery facility, and which would provide the ability to quickly and accurately blend on-spec gasolines "to order" with minimum operated blending time and effort.

A feature of major importance in the design of the blending system was that a continuous flow of an on-

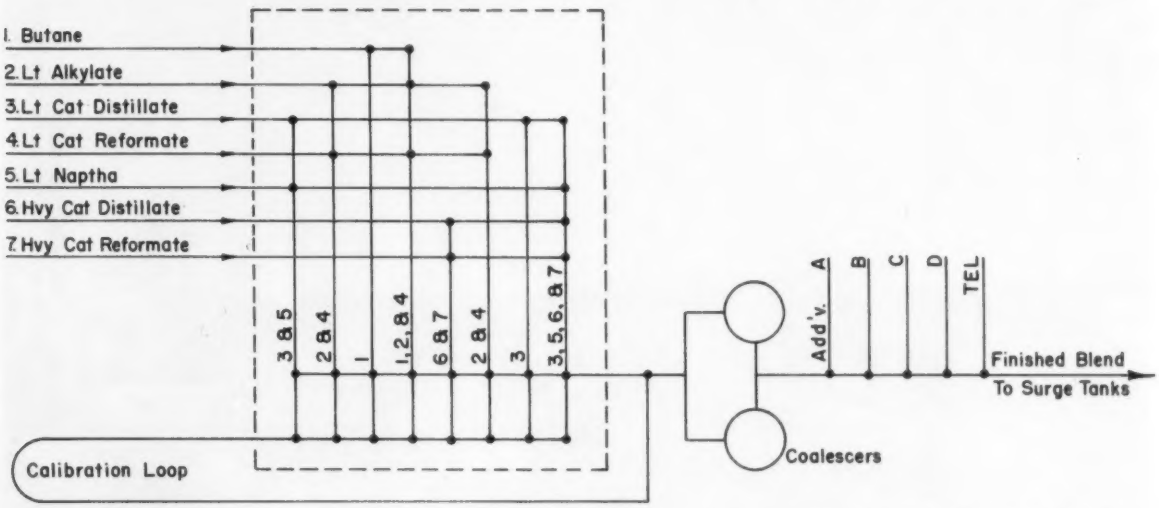


FIGURE 2—The blender is designed to combine seven gasoline components, TEL and four additives as a non-recirculating unit. Eight metering locations permit one small and one large meter to be available in the event of blending failure.

spec product would have to be guaranteed at the blender when shipping by pipe line because finished product tankage facilities were not provided for. This condition makes it imperative that the blend is correct because there is no opportunity to "doctor" the blend once it leaves the blender.

Process Description. The gasoline components are rundown from process or from seasonal storage areas to their respective rundown tanks where they are stored in large volumes and blended off as orders are received. Two rundown tanks are provided for each component. As one tank is being filled, the other is available for blending. When a tank is filled, it is mixed, allowed to settle, and sampled. This procedure is followed on each of the component streams.

The additives and TEL are stored near the blender to consolidate the operations as much as possible.

Blender Manifold. The blender is designed to combine seven gasoline components, TEL and four additives as a non-recirculating unit. The piping manifold includes eight gasoline component metering locations so that one small and one large meter will always be available for sparing in the event of failure during a blending operation. Each of the metered streams can be charged directly into the blending header or diverted into the calibration loop. As many as seven gasoline components can be blended at one time having the eighth meter available as a spare.

The four additive streams are metered in the same manner but there is no full sparing of any on estream. If one of these small meters should fail, it will be replaced with a spare off the shelf.

The TEL is added to the blend by means of a slipstream using "loss in weight" TEL scales energized by a flow recorder and controller in the blender discharge header.

The blender manifold is shown in Figure 2. One other important feature incorporated in this design is a pair of "coalescers" to remove moisture and sediment. These coalescers in the blender header are located downstream of the gasoline components but upstream of the dyes and additives. This prevents fouling of the filters.

Description of Principal Controlling Equipment. The blender is designed around an integrated proportioning control system. It is not the purpose of this article to describe the instruments involved, therefore, only the principal elements and their basic functions will be mentioned.

The principal controls used in the blender operation are as follows:

1. The master control panel, which controls the total volume of finished product being blended and which allows the operator to increase or decrease the volume rate of the total blend by the simple turn of a master hand wheel. This master panel will shut the blender down automatically when a blend is completed.
2. The individual panels for each gasoline component and additive used in a particular blend on which the volume of flow is fixed as a function of the total flow set on the master panel. The master panel setting establishes a ratio through gearing mechanism between the individual component counters and the meters and the total blend counter. Any deviation from a set flow rate is pneumatically corrected at the individual panel board.
3. The interlock system on all valves in the blender manifold which indicates directly or indirectly the stem position of the valves and which will prevent the blender from operating if the valves are not properly lined up.
4. The flow recorder and controller on the blending header which records total flow and energizes the TEL System.
5. The controls for the start up and shut down of gasoline component pumps and additive pumps by the blender operator. This remote control of the

pumping operations allows the pumps to be located at or near their respective component product tanks in place of the conventional pump house arrangements. This design facilitates a most economical piping arrangement.

What Does the Blender Do? As previously stated, the blender is designed to maintain a continuous flow of on-spec gasoline. Several of the more interesting features whereby this is accomplished are discussed below.

Continuous Flow. Since there is no large storage capacity for finished product available, provision for possible unscheduled blender or pipe line shutdown had to be incorporated into the design. Surge tanks are located downstream of the blender between the blender area and the pipe line pump. These tanks, normally operated half full, provide a four-hour product hold-up time. This is considered adequate to get the blender back on stream in event of mechanical failure. These tanks also provide four hours additional product storage which permits the blender to stay on stream in event of pipe line difficulties.

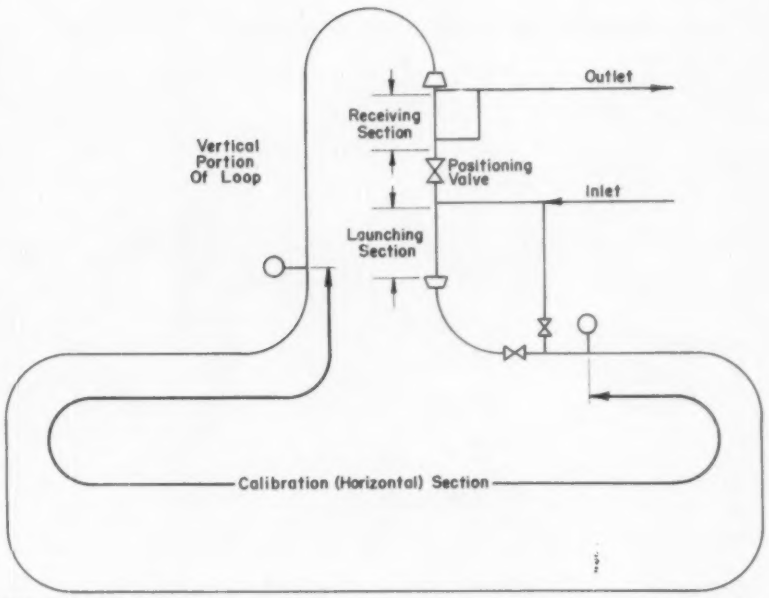


FIGURE 3—The calibration system is composed of a continuous loop of 10-inch pipe. The horizontal section contains a known volume. The vertical section contains the receiving and launching section for the calibration pig.

Metering. The positive displacement meters are among the most important pieces of equipment in the blender. These meters with a minimum amount of calibration will measure a finished blend within an over-all accuracy of 0.5 percent. Calibration of these meters will be covered later.

Failure of any metered stream to meet the blender requirements due to equipment failure will automatically shut down the blender.

Possible operator error in lining up any of the metered streams will be detected on the control panel through the valving interlock system. Should

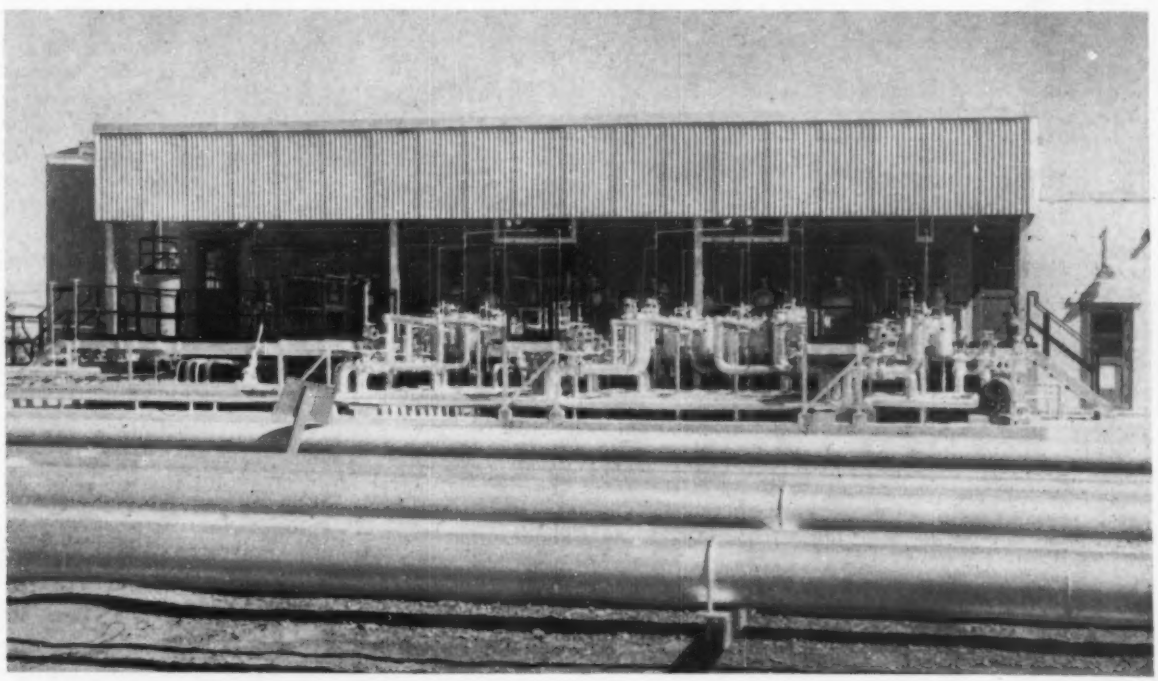


FIGURE 4—The interlock system on all valves indicating the stem position of the valves prevents the blender from operating if the valves are not properly set. The flow recorder and controller then register the total flow.

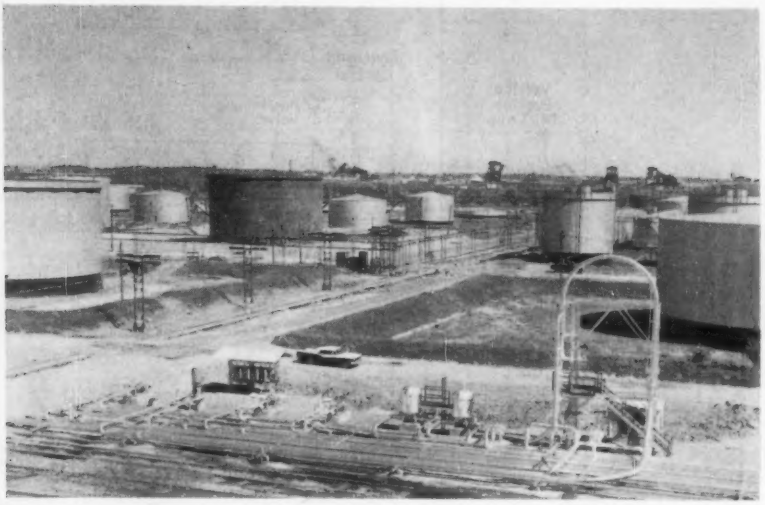


FIGURE 5—The vertical pipe contains the receiving and launching section for the calibration pig. After each run, the pig falls by gravity into the launching position for the next run.

the blender operator fail to recognize the error and try to start the blender, it will not operate.

Sampling. There are a number of points in the system where samples may be taken to determine the qualities of the components and the product. Two continuous samplers are also included. These continuous samplers can be set up on a time basis whereby the entire blend will be sampled intermittently and collected within one container. One sampler is located on the blender discharge line and the other on the discharge of the product pump sending the blend to the pipe line. Prior to blending a particular stream the component run-down tanks will have their inlets sealed after the tank has been mixed to insure that no other product will be dumped into the tanks after they have been sampled.

Calibration. The calibration systems are a necessary part of the initial blender operations. Calibrations, however, will not have to be performed with each new blend once sufficient performance data has been collected. The function of the calibration system is to determine the initial discrepancies in the metering devices and to measure the rate of change in meter accuracy that takes place.

Two separate and distinct systems were designed; one for the small additive meters and the other for the larger gasoline component meters.

The additive meter calibration system is comprised of a small pump, a calibration tank and a small storage container. The meter to be calibrated is placed in this pump circuit and a known volume of fluid is pumped through it. This calibrated meter can then be placed in series with each of the additive meter circuits to determine their error.

The calibration system used for the component meters is shown in Figure 3. It is composed of a continuous loop of 10-inch pipe, a specific section of which contains a known volume. This section of the loop is the same as any other calibration loop in use today. However, the launching and receiving sections differ radically from anything that has been done to date. A vertical section was installed as part of the loop which contains these receiving and launching sections. After each run with the "calibration pig," the pig is re-positioned for the next run by merely opening a gate valve located in the vertical—allowing the pig to fall by gravity into the launching section of the loop. This design provides several advantages over the conventional method. Some of the important advantages are: (1) operator time and effort are reduced; (2) butanes and other light ends are not vented to the atmosphere when re-positioning the pig and (3) slop tanks and pumps are not required to drain the launching and receiving sections.

Experience to Date. The blender was checked and put on stream prior to the startup of new refining facilities at Toledo. High quality, on-spec blends were made with good accuracy directly to the pipe line. When the new facilities are on stream, Sohio will be using the continuous blender on a routine basis for the production of finished gasolines. # #

About the Authors

Applequist

Krebs

H. D. Applequist is a group engineer in the Manufacturing department of The Standard Oil Co. (Ohio). Currently, he heads the Engineering Investigations group responsible for the economic evaluation of new processing techniques and products. He joined Sohio in 1951 as a maintenance engineer at the company's Latonia, Ky., refinery. In 1955, he joined the Process Engineering division of the company's technical organization. He was actively engaged in the design of off-site facilities, including the gasoline blender for Sohio's new Toledo refinery. Applequist has a degree in mechanical engineering from the University of Cincinnati.

James E. Krebs is a member of The M. W. Kellogg Co.'s offsites group, and in this capacity was in charge of Kellogg's work on Sohio's Toledo refinery. He joined Kellogg in 1952 in the Piping Production department, was a field engineer and chief engineer on one project as a member of the Construction department, and worked with the Structural group before starting his present assignment. Krebs was awarded a Kellogg Scholarship for graduate study in 1957 to work on his M.I.E. degree. He has a B.C.E. degree from Manhattan College, is a licensed professional engineer in New York, and is a member of the A.S.C.E.

Take a look at . . .

Hexamethylene Tetramine

This versatile chemical consumes two important petrochemicals: formaldehyde and ammonia. You'll find a complete discussion here on . . .

- **Consumption patterns**
- **Manufacturing methods**
- **Reaction conditions**

Peter W. Sherwood, White Plains, N. Y.

HEXAMETHYLENE TETRAMINE is the condensation product of two petrochemical intermediates: formaldehyde and ammonia.

Among end users for formaldehyde, hexamine stands in fourth position, accounting for slightly more than 9 percent of total demand in 1957. Only the manufacture of resins, pentaerythritol, and of ethylene glycol exceed this share of formaldehyde's market.

Among consumers of ammonia, which derives 79 percent of its domestic market from demand for fertilizer applications, hexamine occupies a less crucial position. Nevertheless, its production in 1957 accounted for the use of an estimated 12 million pounds of ammonia.

Both of hexamethylene tetramine's raw materials are predominantly derived from petroleum hydrocarbons. Some 87 percent of the nation's formaldehyde output is obtained by partial oxidation of methanol of which, in turn, 63 percent is produced from methane-derived synthesis gas. The remaining share of formaldehyde output is obtained as one of several products in the partial oxidation of a propane-butane fraction.

Ammonia, the second raw material in hexamine synthesis, is obtained by the high-pressure reaction of atmospheric nitrogen with hydrogen. Key to its manufacturing economics is the source of hydrogen. Today, some 90 percent of ammonia-bound hydrogen is obtained from two petroleum sources: synthesis gas derived from methane and byproduct hydrogen formed in the course of catalytic reforming operations. The latter source has shown considerable growth during the last five years; in 1956, it accounted for 10 percent of ammonia synthesized in the U. S.

Over the years, hexamethylene tetramine production volume has been of prince-and-pauper character. Its sales hinge principally on two outlets: Manufacture of RDX (nitrated hexamethylene tetramine), a high explosive, and use in resin production, principally as curing agents for thermosetting plastics.

Production of RDX is practically nil during peacetime. It occupied, however, an important position during World War II as well as during the Korean action, and the year 1953 has been the record year for hexamine, with an output of 57 million pounds. As a result, capacity for hexamethylene tetramine production is quite adequate to meet current requirements: U. S. output was 29.3 million pounds in 1956, 22.6 million pounds in 1957.

In the peacetime economy, hexamine's principal outlet is as curing agent for thermosetting resins. It is thus tied to a branch of the industry for which an average growth rate of 3 percent per year is foreseen between 1957 and 1962.

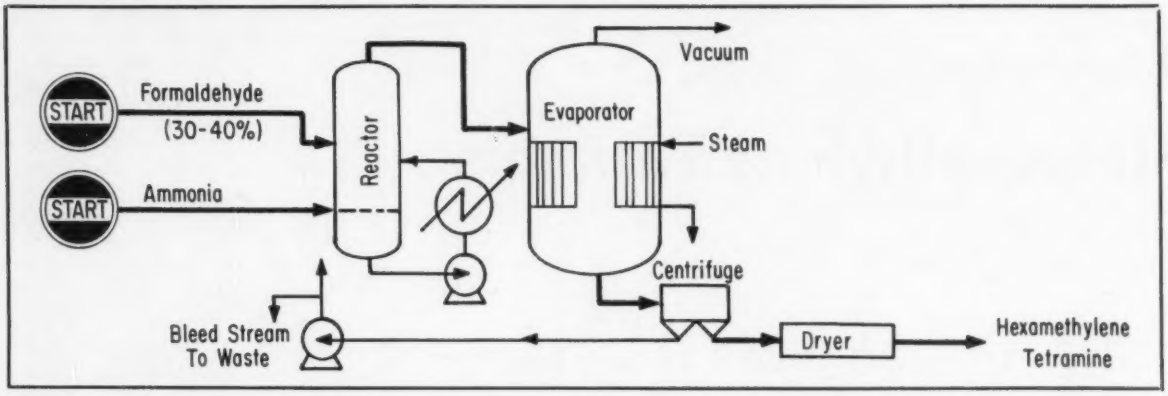
In this field, hexamethylene tetramine serves in several capacities. For example, it is a methylenating agent in the curing of phenol-formaldehyde resins. Incorporated into the batch, the compound is broken down thermally in the course of the molding operation. The decomposition products are ammonia, which acts as catalyst, and methylene groups which yield a harder product by providing cross-linking. Unlike paraformaldehyde, hexamethylene tetramine is able to achieve this release of methylene group without formation of water, an important advantage.

It is estimated that incorporation into thermosetting resin formulations accounts for 75-80 percent of hexamine's peacetime consumption. The remainder enters a large variety of different fields, of which a few might be cited.

An outlet exists in the rubber industry where the compound is used as accelerator and to prevent vulcanized rubber from "blocking." A fairly extensive use is in the production of incendiary mixtures and detonator preparations.

Pharmaceutical applications exist for both hexamethylene tetramine itself and for some of its derivatives. The parent compound is prescribed as a urinary antiseptic under various names.

A number of applications for hexamine are in the developmental or exploratory commercial stage. Among the more promising of these, mention may be made of the use of hexamine as fungicide in the citrus fruit industry, as insecticide carrier deactivator (to stabilize endrin-based dust formulations), as inhibitor of corrosion by strong mineral acids, and as isolubilizing agent for proteins. Finally, hexamethylene tetramine is used by the textile industry for shrink-proofing purposes, to improve color fastness,



Hexamethylene tetramine is usually made in this manner. Notice the external exchanger for reaction temperature control and high vacuum evaporation to keep temperature low.

and to achieve better elasticity in cellulosic fibers.

MANUFACTURE OF HEXAMETHYLENE TETRAMINE

The synthesis of hexamethylene tetramine proceeds in accordance with equation (1):

$$6\,HCHO + 4\,NH_3 \rightarrow C_6H_{12}N_4 + 6\,H_2O \qquad (1)$$

The reaction is exothermic (363 Btu/lb product). It proceeds in the vapor phase as well as liquid phase but, for reasons of yield, the latter course is universally chosen. Water is the reaction medium.

The over-all flow scheme in hexamine production is straight-forward. Aqueous (30-40 percent) formaldehyde is contacted with gaseous ammonia. Cooling is provided to maintain the temperature of the system at about 30 C.

The reactor effluent is fed to a vacuum evaporator. Here primary product is concentrated and crystallized. The crystals of hexamethylene tetramine are centrifuged, washed, and again centrifuged to a 1 percent water content. A final drying step reduces moisture content to less than 0.5 percent.

The mother liquor, which is separated in the centrifuging step, is normally recycled to the reactors. In this case, a small bleedstream is withdrawn to prevent excessive buildup of impurities. Alternatively, the entire primary mother liquor may be further concentrated and centrifuged for recovery of a somewhat lower-grade hexamine. This product can be raised to USP grade by recrystallization from water.

Actual execution of the process is subject to a number of problems in both the reaction and recovery stages. These problems include establishment of optimum process conditions, selection of process equipment, and choice of construction materials.

CHOICE OF REACTION CONDITIONS

Kinetics of the Reaction. The mechanism of hexamethylene tetramine synthesis is not yet clearly established. Early work by Baur & Ruetschi[1] indicates a one-step trimerization reaction of the third order, in which the rate is proportional to $(NH_3)(HCHO)$.[2]

Subsequent investigations by Boyd & Winkler[2] led to the formulation of a more complex mechanism. Two independent routes appear to be involved, and the predominating mechanism depends on whether ammonia or formaldehyde is present in excess.

For a detailed discussion of the mechanism of hexamine synthesis, the interested reader is referred to Boyd's paper.[2] Certain it is that theoretical aspects of this reaction are not yet satisfactorily resolved, and the entire development of the manufacturing process has had to rely on empirical methods.

Raw Materials and Reaction Medium. Ammonia is supplied to the reaction system in gaseous form. Formaldehyde is normally supplied in aqueous (37 percent) solution. This grade of commercial formalin is inhibited with methanol. According to Latapie,[3] methanol content of the formaldehyde solution should not exceed 2 percent in the manufacture of pharmaceutical-grade hexamethylene tetramine. This restriction is not, however, universally honored and methanol concentration as high as 10 percent is permitted in the raw material of at least one commercial hexamine plant in England.

Methanol introduced with the charge material leaves the reactors with the crude product. It is removed and recovered as overhead in the vacuum evaporators which serve to concentrate the hexamethylene tetramine solution.

The use of dilute gaseous formaldehyde in hexamethylene synthesis has been proposed by Meisner.[4] In this process, the feed is a product stream obtained directly from formaldehyde synthesis converters. This stream, together with ammonia, is passed into aqueous medium where conversion to hexamethylene tetramine is allowed to take place. Very high yield on both of the raw materials is claimed, but commercial utilization of the process has not come to the writer's attention.

Water serves universally as reaction medium in hexamethylene tetramine

synthesis. Mother liquor, obtained in the first separation of hexamine crystals, is commonly recycled to the converters in order to boost over-all product recovery.

Various proposals have been made to use reaction media other than water. Such an approach is claimed to be more amenable to continuous processing and to permit recovery of hexamine without vacuum evaporation. Among solvents in this category, we might mention the suggested use of alcohol, which calls for a feed of anhydrous formaldehyde[5] and the use of ketones which are to be used as formaldehyde dehydration agent during the reaction step.[6]

Reaction Condition. The efficiency and progress of the reaction in hexamethylene tetramine synthesis is controlled by three operating variables: temperature, reactants' ratio and pH.

The reaction may be carried out at temperatures up to about 50 C. Above this temperature, rate of hexamine decomposition becomes excessive, although one continuous process has been developed in which a brief temperature rise up to 70 C. is allowed with safer, low temperatures maintained during most of the reaction period.

Boyd[2] has shown that the shape of the rate curves differs markedly at 0 C. and 35 C., presumably due to the predominance of different reaction mechanisms at these two levels. Interestingly, the initial rate of reaction is greater at the lower temperature but, this effect is offset, after about 5 minutes. Regardless of temperature in the 0-35 C. range, approximately the same per-pass conversion to hexamethylene is reached assymptotically.

To reach maximum yield in batch operation would call for reaction times as high as six hours. Actually, the increase in useful conversion during the last 4-5 hours of this period is not significant enough to warrant hold-up times much in excess of one hour, even in batch processing. In continuous operation, of course, contact time during each pass may be as low as 15-30 minutes; unconverted formaldehyde as well as intermediate products in hexamine formation, are recycled with the mother liquor obtained from centrifugation of the crystallized product.

pH of the reaction medium is normally held between 7 and 8. At more acidic conditions, considerable loss occurs due to a side reaction which yields eventually formic acid, carbon dioxide, and water.

The pH itself is adjusted by control of the reactants' ratio, and the rate of ammonia introduction is regulated to maintain the reaction liquor just slightly above neutral point at all times. Over-all, this means that ammonia is fed in approximately two percent above stoichiometric requirements.

Reaction Equipment. Conversion is carried out in a vessel or tower which is either provided with internal cooling coils or which is cooled by circulating the reaction liquor through an external heat exchanger.

According to Simmons,[7] the reactors at the hexamethylene tetramine plant of England's I.C.I. are welded aluminum vessels, 8 feet 6 inches in diameter and 12 feet high. Ammonia is introduced through a circular perforated pipe which is located in the base of the tower. Cooling is provided by continuous circulation of the reaction liquor through stainless steel, calandria-type heat exchangers.

A somewhat different reactor design serves in a process described by Schideler.[8] Here, the reaction column consists of two main sections. The lower part is filled with formaldehyde solution. Gaseous ammonia is introduced into the liquid through a distributor at the column's base. Formalin is fed at mid-point, near the point of its entry, cooling coils are provided to hold the temperature below 55 C.

The converter's upper section begins directly above the formaldehyde feed point. This part is of shell-and-tube design. Reaction liquor passes upward through the tubes and water, circulated through the shell, serves as cooling medium.

The process stream passes from the top of the converter to a baffled tank in which some further reaction is allowed to occur between the residual ammonia and formaldehyde. A portion of the make is drawn from this tank to the vacuum evaporator, but the bulk is recirculated to the base of the converter. A high recirculation: feed ratio is maintained. As a result, concentration of formaldehyde and ammonia in the medium is low at any time and the extent of side reactions is reportedly minimized.

Product Recovery. Concentration of reactor effluent stream is effected by evaporation under sufficient vacuum to keep the temperature below 50 C., i.e., below the point where hexamethylene tetramine decomposition becomes a serious factor. Crystallization is allowed to take place in the evaporator. Here, advantage is taken of the inverse solubility curve of hexamine: at 25 C, 86.7 grams will dissolve in 100 cc water, while at 50 C, the solubility is only 80.8 grams/100 cc.

As the solution is depleted of residual ammonia, there is a tendency for hexamethylene tetramine to decompose to its raw materials. This may be offset[3] by continuous introduction of a small amount of ammonia into the evaporator in order to displace the reaction equilibrium in favor of hexamethylene tetramine formation. Ammonia is withdrawn overhead, together with the evaporated water. The overhead stream also contains methanol which was introduced into the system as inhibitor for formaldehyde, and which may be concentrated in a separate distillation step.

Evaporators in hexamethylene tetramine service are built of stainless steel. Product is accumulated in a stirred salt box and is removed as a thick slurry.

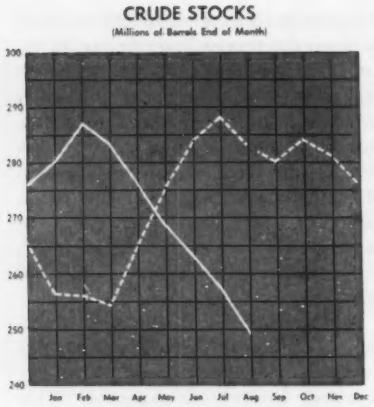
Separation of the product crystals from associated water in the evaporator product is accomplished in centrifugals. Again, equipment elements which are in direct contact with the product, are made of stainless steel. As has been previously noted, the mother liquor, which is obtained in the course of centrifugation, is recycled to the reaction stage.

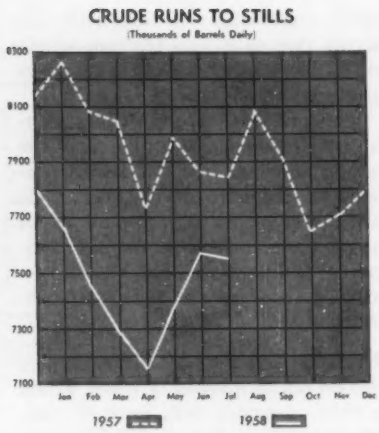
The centrifuged salt contains about one percent water and a final drying step is called for. Here, once again, the temperature must be held below 50 C in order to minimize decomposition of the product.

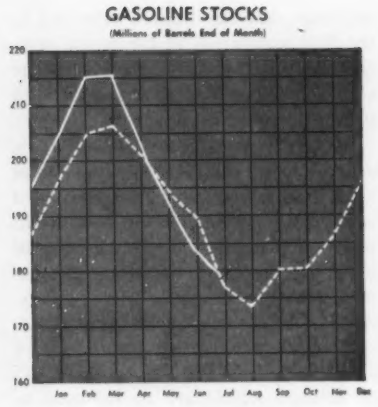
Over-all, the commercial synthesis of hexamethylene tetramine can be carried out with good efficiency. Typical yield in recycle operation is of the order of 95-96 percent on formaldehyde and only slightly less on ammonia.

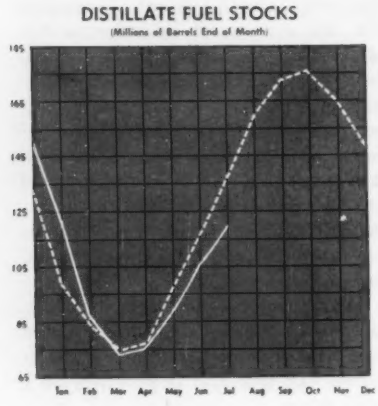
LITERATURE CITED

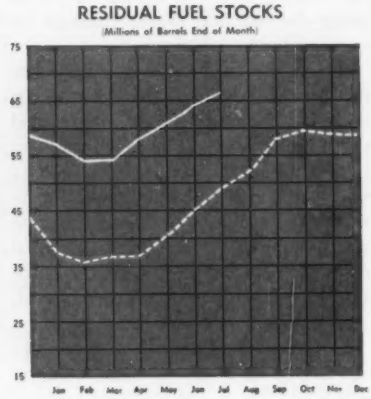
[1]Baur, E. and Ruetschi, W. Helv. Chim. Acta 24, 754 (1951).
[2]Boyd & Winkler. Can. J. Res. 25, Sec. B, 389.
[3]Latapie, F. V. Ion 23, 338 (1943).
[4]Meissner, F. U.S. 2, 762, 799, September 11, 1956.
[5]Landt and Adams. U.S. 1, 774, 929, September 2, 1930.
[6]Eickmeyer, H. G. U.S. 2, 542, 315, February 20, 1951.
[7]Simmons, W. H. et al. Ind. Chemist, August 1948. 530 ff.
[8]Schideler, P. et al. U.S. 2, 449, 040 to Chemical Construction Corp., September 7, 1948.

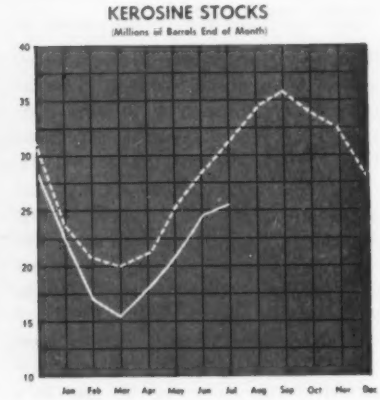












Taking Stock

- Crude stocks continue to drop
- Crude runs down slightly
- All other stocks following seasonal trends

U. S. Monthly Oil Trends

(THOUSANDS OF BARRELS DAILY)

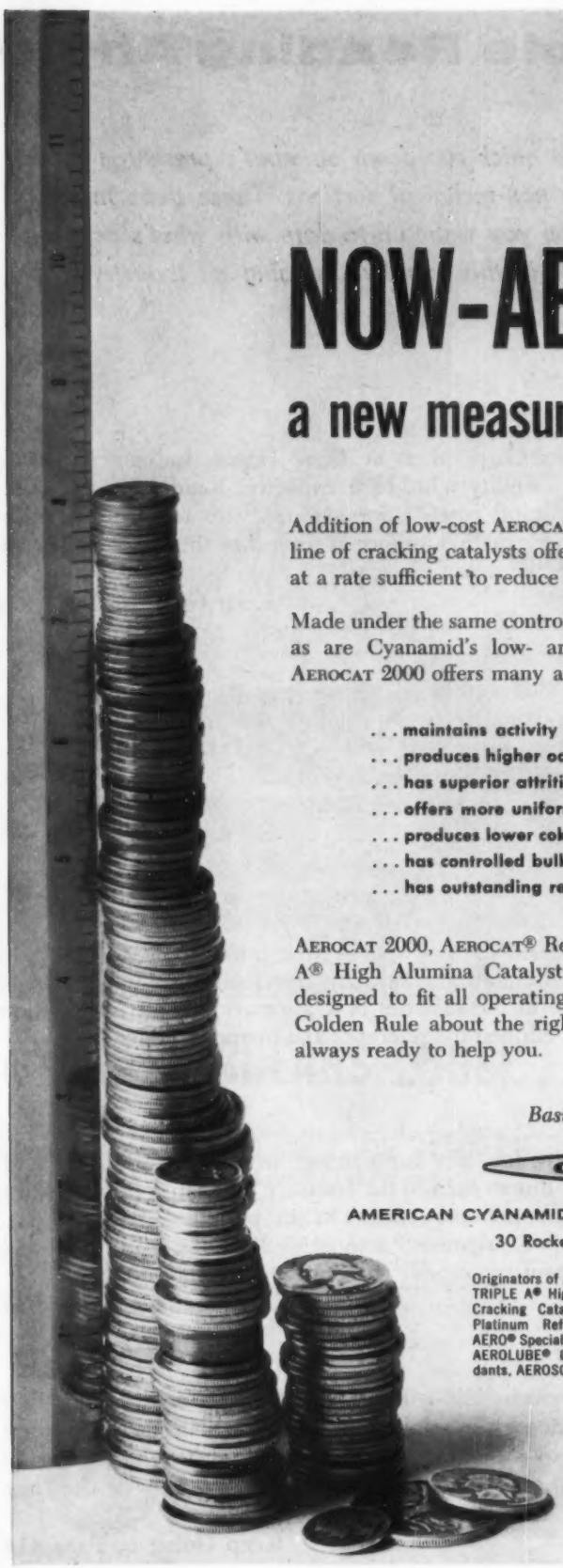
	JULY			June	JANUARY-JULY		
	1958	1957	% Diff.	1958	1958	1957	% Diff.
U.S. Crude Oil Production	6,504	6,873	— 5.4	6,335	6,469	7,403	—12.6
U.S. Nat. Gas Liquid Prod.	780	734	+ 6.3	750	781	806	— 3.1
U.S. Imports	1,597	1,601	— 0.3	1,580	1,639	1,519	+ 7.9
East Coast Crude Imports	685	840	—18.5	700	752	711	+ 5.8
Total Crude Imports	852	1,180	—27.8	950	924	958	— 3.6
Total Refined Products	745	421	+76.9	630	714	560	+27.5
Total New Supply	8,826	9,208	— 4.2	8,666	8,881	9,727	— 8.7
Stock Changes All Oils (Daily)	—99	+544	.....	+70	—351	+183	.....
Total Demand All U.S. Oils	8,925	8,664	+ 3.0	8,596	9,232	9,544	— 3.3
Gasoline Demand	4,275	4,285	— 0.2	4,182	3,884	3,938	— 1.4
Distillate Fuel Demand	1,210	1,095	+10.5	1,153	1,848	1,874	— 1.4
Residual Fuel Demand	1,300	1,334	— 2.6	1,232	1,510	1,664	— 9.3
Domestic Demand, All Oils	8,675	8,271	+ 4.5	8,346	8,970	8,833	+ 1.6
Export Demand, All Oils	250	392	—36.2	250	261	711	—63.3
Crude Runs U.S. Refineries	7,564	7,852	— 3.7	7,578	7,312	7,980	— 8.4
Domestic Crude Runs	6,658	6,696	— 0.6	6,601	6,550	7,042	— 7.0
Foreign Crude Runs	906	1,156	—21.6	977	921	938	— 1.8

	TOTAL U.S. STOCKS Millions of Barrels End of Month				STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month			
	July			June	July			June
	1958	1957	% Diff.	1958	1958	1957	% Diff.	1958
Crude Oil	249.9	288.2	—13.3	257.3	207.5	252.3	—17.8	212.4
Gasoline	178.7	177.9	+ 0.4	184.7	153.6	152.0	+ 1.1	158.7
Distillate Fuel Oil	120.4	138.4	—13.0	105.2	107.1	123.6	—13.4	92.1
Residual Fuel Oil	66.9	49.6	+34.9	64.3	34.3	32.7	+ 4.9	32.1
Kerosine	25.9	31.7	—18.3	24.2	25.5	31.4	—18.8	23.8

Source: Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report, except U.S. Natural Gas Liquids Production and Demand figures which are estimated by World Oil.

NOW-AEROCAT® 2000

a new measure of catalyst economy



Addition of low-cost AEROCAT® 2000 Fluid Cracking Catalyst to Cyanamid's line of cracking catalysts offers refiners new economy where catalyst is used at a rate sufficient to reduce the effect of heavy metals.

Made under the same controlled conditions, by the same advanced processes as are Cyanamid's low- and high-alumina synthetic cracking catalysts, AEROCAT 2000 offers many advantages over other low-cost catalysts:

- . . . maintains activity stability with greater economy
- . . . produces higher octanes
- . . . has superior attrition resistance
- . . . offers more uniform physical and catalytic properties
- . . . produces lower coke
- . . . has controlled bulk density for better fluidization
- . . . has outstanding regeneration properties

AEROCAT 2000, AEROCAT® Regular Fluid Cracking Catalyst, AEROCAT TRIPLE A® High Alumina Catalyst – a complete line of high efficiency products designed to fit all operating conditions. Talk to Cyanamid's Man with the Golden Rule about the right AEROCAT Catalyst for *your* operation. He is always ready to help you.

Basic in Catalyst Chemistry

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

Originators of AEROCAT® Fluid Cracking Catalysts, AEROCAT TRIPLE A® High Alumina Catalysts, AEROCAT® 2000 Fluid Cracking Catalyst, AEROFORM® Fluid Hydroforming and Platinum Reforming Catalysts, AERO® HDS Catalysts, AERO® Specialty Catalysts, CYPAN® Drilling Mud Conditioner, AEROLUBE® Lubricating Oil Additives, AERONOX® Antioxidants, AEROSOL® Surface Active Agents.

For more data on advertised products, use Readers' Service Cards, last page.

Valuable Reading Ahead

Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.

New Methylamine Plant

The new Commercial Solvents Corp. plant at Terre Haute, Indiana is now in full production, and couples flexibility with high capacity. Read how a streamlined design has helped cut capital costs. Completion of this plant is of special interest because of the new uses for methyl amines in several of the new missile fuels and organometallic compounds. To learn more . . .

Keep Going to Page 373

Perforation Problem?

Been having trouble binding those perforated PETROLEUM REFINER pages? When you punch binder holes, do you inadvertently cut into the print? The answer to your "perforation problem" is in this month's "How To Do It." You will also learn how one company "chain-operates" an inaccessible valve, and how another made accurate valve-packing installation foolproof.

Keep Going to Page 362

New Format

PETROLEUM REFINER'S handy "Meetings Calendar" has been expanded to two columns to give you extra advance notice of all the important conventions and meetings in the industry—several months in advance. You'll find it an easy-to-read tabulation of what's coming up in the societies and associations that are of most interest to you. It can be easily clipped for reference at a moments notice.

Keep Going to Page 441

The Latest Thing

Women usually have a sharp eye for "the latest thing" in fashions (the source of many a depleted pocketbook). But to men in the Industry "the latest thing" means new methods, ideas, and equipment to save money in this period of the "tight dollar." That's why "What's New in Equipment," a monthly REFINER feature, is there —so you can learn firsthand about the newest equipment items for your plant.

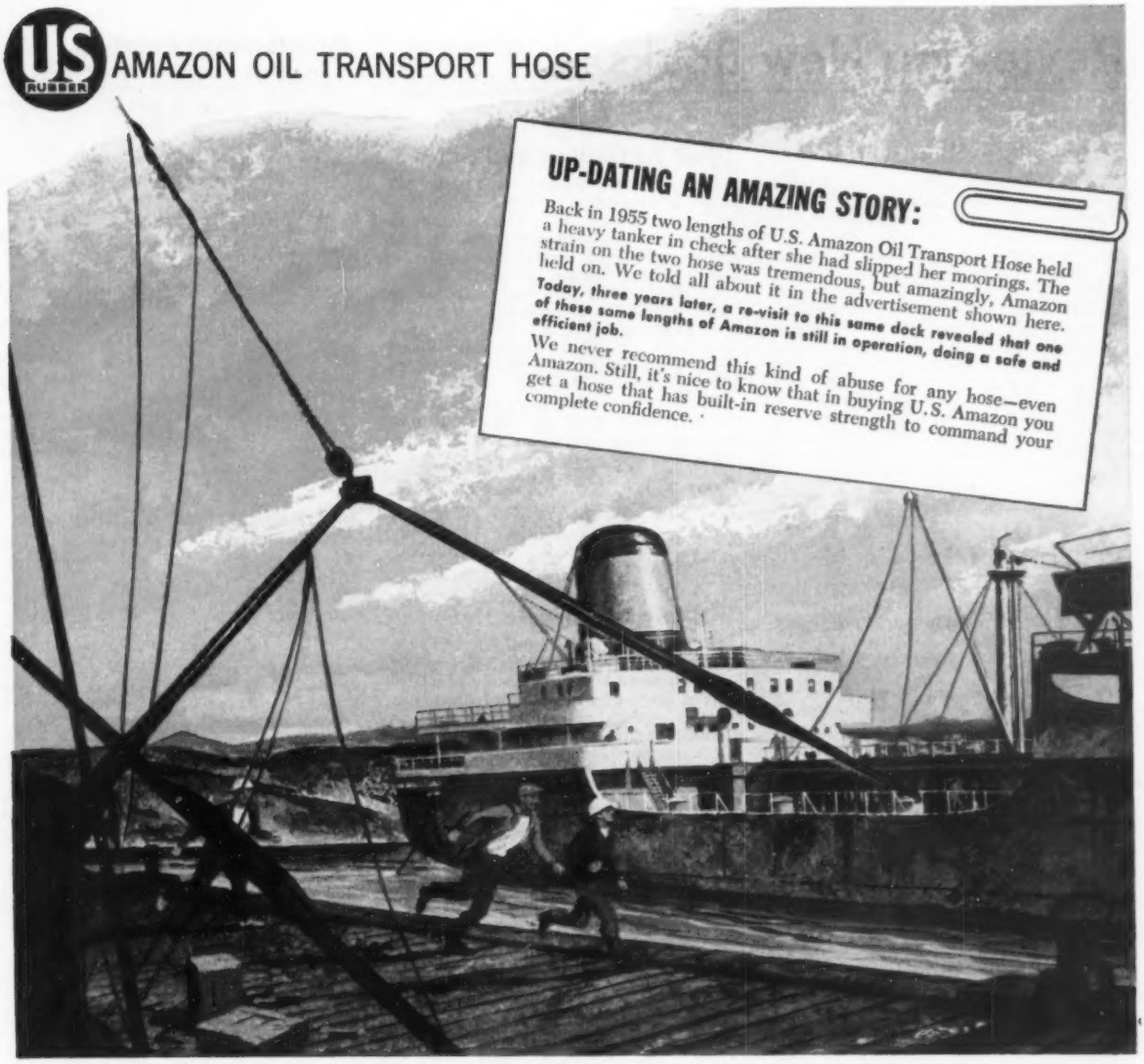
Keep Going to Page 486

Read What's Happening

"What's Happening in the Industry" is a timely presentation of the items that made the news last month. The clear, concise manner in which the events are reported is just what's needed by busy industry men who don't have time to wade through unimportant details to reach the meat of the subject. Now is the time to read "What's Happening in the Industry."

Keep Going to Page 414

US RUBBER AMAZON OIL TRANSPORT HOSE



UP-DATING AN AMAZING STORY:

Back in 1955 two lengths of U.S. Amazon Oil Transport Hose held a heavy tanker in check after she had slipped her moorings. The strain on the two hose was tremendous, but amazingly, Amazon held on. We told all about it in the advertisement shown here. **Today, three years later, a re-visit to this same dock revealed that one of these same lengths of Amazon is still in operation, doing a safe and efficient job.**

We never recommend this kind of abuse for any hose—even Amazon. Still, it's nice to know that in buying U.S. Amazon you get a hose that has built-in reserve strength to command your complete confidence.

TANKER BREAKS LOOSE . . . "U. S." Hose holds on

Helplessly, the big tanker drifted away from the pier. She had slipped her moorings. Her sole connections with the shore were two lines of U. S. Amazon® Oil Transport Hose, one forward, one aft.

As the heavy, sluggish tanker edged further out, tremendous strain began to build up on the two hose, each consisting of two 25-foot lengths. *But U. S. Amazon Hose held.*

Soon each 50-foot line of hose was, as the picture above indicates, stretched like a rubber band—in fact, stretched out to 114 feet, over twice its normal length.

But U. S. Amazon Hose held—

When the tanker was brought back to the pier, astounded engineers removed the hose and tested it to 200 lbs. pressure. No leakage or other damage was found. Most amazing of all, each of these stretched and strained lengths recovered all but one foot of its original length.

This totally unexpected use of U. S. Amazon Hose as a hawser is a dramatic example of the value of "U. S." wire cord construction—which can take more longitudinal abuse or other deformations than conventional woven duck hose.

U. S. Amazon H-1515 is recommended for discharge—H-1818 for both suction and discharge service.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

US RUBBER **United States Rubber**

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

Reviewing New Books . . .

Absorption Oil Testing

The 1958 revision of Bulletin TS-343, "Tentative Standard Methods for Testing Absorption Oil," has been published.

With the use of low molecular weight absorption oils for increasing absorbing capacity, lean oil losses into the absorber residue gas has become a significant factor.

This bulletin includes two new methods for estimating oil losses to the residue gas. One is a direct measurement technique using a charcoal absorption test, and the other is a calculation method based on a distillation of the absorption oil losses.

(Absorption Oil Committee, *Tentative Standard Methods for Testing Absorption Oil,* California Natural Gasoline Association, 510 W. 6th St., Los Angeles 14, Calif., 33 pages, $3.00 for non-members, $2.00 for members.)

Properties of Gas, Liquid

In "The Properties of Gasses and Liquids", the authors present a critical review of the methods useful in correlating or estimating the more important physical properties of pure materials and simple mixtures.

Each property is first discussed from a theoretical standpoint. Both theoretical and empirical methods of estimating the property for new substances are then discussed and compared. The methods are applied to the extrapolation of experimental data to unexplored ranges of such variables as temperature and pressure.

(Reid, R. C., Sherwood, Thomas K., *The Properties of Gasses and Liquids,* McGraw-Hill Book Co., Inc., 330 W. 42nd St. New York 36, N. Y., 576 pages, $10.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Become a Professional!

Unlicensed engineers can benefit from "How to Become a Professional Engineer". This is a clear guidebook for both the unlicensed engineers-in-practice and young graduates on how to obtain a professional license.

The author lists and clarifies the seven basic requirements for licensure; summarizes in plain terms the various state registration laws; and shows clear examples of how examining boards evaluate the experience of the candidate.

The book also explains how to prepare an application; gives pointers on selecting the qualifying experience and writing it up; shows how to prepare for written and oral examinations and how to avoid emotional stress during tests; points out what to look for—including pitfalls—in refresher courses; and tells how to achieve multiple-state registration.

The book is applicable in all states, showing what all boards aim for. There is a chapter on the engineer's seal and its use, and extensive appendixes list name and addresses of state board secretaries, accredited schools, and recommended texts.

(John Constance, *How to Become a Professional Engineer,* McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 272 pages, $5.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

1957 ASTM Proceedings

The American Society for Testing Materials is publishing its "1957 ASTM Proceedings, Volume 57." The volume, recording the technical accomplishments of the year, includes reports and papers together with discussion offered to the Society during the year and accepted for "Proceedings." It includes the summary of proceedings of the ASTM 60th Annual Meeting and the Philadelphia Spring Meeting, listing the programs for each session by title and author.

In addition to the papers and reports in "Proceedings," there are listed all symposia and other special sessions published separately as Special Technical Publications, and all papers published in the ASTM Bulletin.

(ASTM, 1957 *ASTM Proceeding, Volume 67,* American Society of Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1430 pages, $12.)

Anti-corrosion Additives

"Corrosion Preventive Additives" is the final report of a year (1951-1952) of Air Force-sponsored research aimed at development of new corrosion inhibitors to supplement or replace petroleum sulfonates as lubricant additives has just been released.

A large number of commercially available organic compounds were evaluated by the Static Water Drop test and a galvanic couple system. Several good inhibitors were found, and general information was obtained concerning the type of organic compounds which will inhibit galvanic corrosion.

The research produced many synthetic organic compounds showing corrosion inhibiting properties. Among these were glyoxalidines, alkyl arly sodium sulfonates, amine salts of 2-ethylhexoic, oleic, nicotinic, pelargonic, linoleic, and dodecylbenzenesulfonic acids.

(U. S. Air Force-sponsored Research Team, *Corrosion Preventive Additives, PB 131459,* Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., 120 pages, $3.00.)

ASA 1957 Revisions

American Standards Association revisions made in 1957 affect these standards: ASTM Designation A 181-57 T, ASA G46.1-1958, Tentative Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service (ASME Boiler and Pressure Vessel Code Specification No. SA-181);

ASTM Designation A182-57 T, ASA G37.1-1958, Tentative Specifications for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (ASME Boiler and Pressure Vessel Code Specification No. SA-182).

Changes in revised American Standard G46.1 (ASTM A181) affect material for forgings and retests.

Changes in revised American Standard G37.1 (ASTM A182) affect material for forgings, hydrostatic test, and retests.

(ASA, *Revised Standards,* American Standards Association, Dept. PR 4, 70 E. 45th St., New York, N. Y., $.30 per copy).

Maintenance Painting

This book is written especially for the use of painting and coating supervisors, contractors, painters, and design maintenance engineers in industrial plants. The author has avoided the technical language used by corrosion engineers, chemists, etc., in discussing corrosion and the application of protective coatings.

Included are these chapters: Surface Preparation, Protective Coatings, Coating Application, Shop Painting of Steel, Inspection, Specification Writing, Paint Testing, Comparative Costs, Steel Design for Corrosion Prevention, Cost Estimating, Tank Cars and Vessels, Solvents, Colors, and Painting Economics.

There are two appendixes with tables and notes on coatings and cathodic protection.

(Weaver, Paul E., *Industrial Maintenance Painting,* Paul E. Weaver, 4025 Brady St., Baton Rouge, La., 189 pages $5.50.)

Petroleum Tax Manual

"Manual Relating to Federal Excise Taxes on Gasoline, Special Motor Fuels, Diesel Fuel and Lubricating Oil," issued by the American Petroleum Industries Committee of the API, is ready for distribution.

Incorporated in its 14 chapters are 121 rulings of general interest relative to various questions regarding federal excise taxes. The manual contains 21 forms and other documentation required by federal law and regulations. Its pages are punched for insertion in any standard three-ring looseleaf binder.

(API American Petroleum Industries Committee, *Manual Relating to Federal Excise Taxes on Gasoline, Special Motor Fuels, Diesel Fuels and Lubrciating Oil,* Coyne and Co., Inc., 114 E. 13th St., New York 3, N.Y., 115 pages, $2.00.)

A Guide to Plastics

"A Guide to Plastics", second edition, tells of the many important developments that have taken place since the publication of the first edition. The author gives a comprehensive picture of the whole field of plastics, and explains exactly what "plastics" are and how plastic products are made. He describes clearly and in detail the basic and intermediate raw materials employed, the manufacture of plastic materials from them, and the various processes by which those materials are fabricated into finished goods for commerce and industry.

(Redfarn, C. A., *A Guide to Plastics,* Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 150 pages, $7.50.)

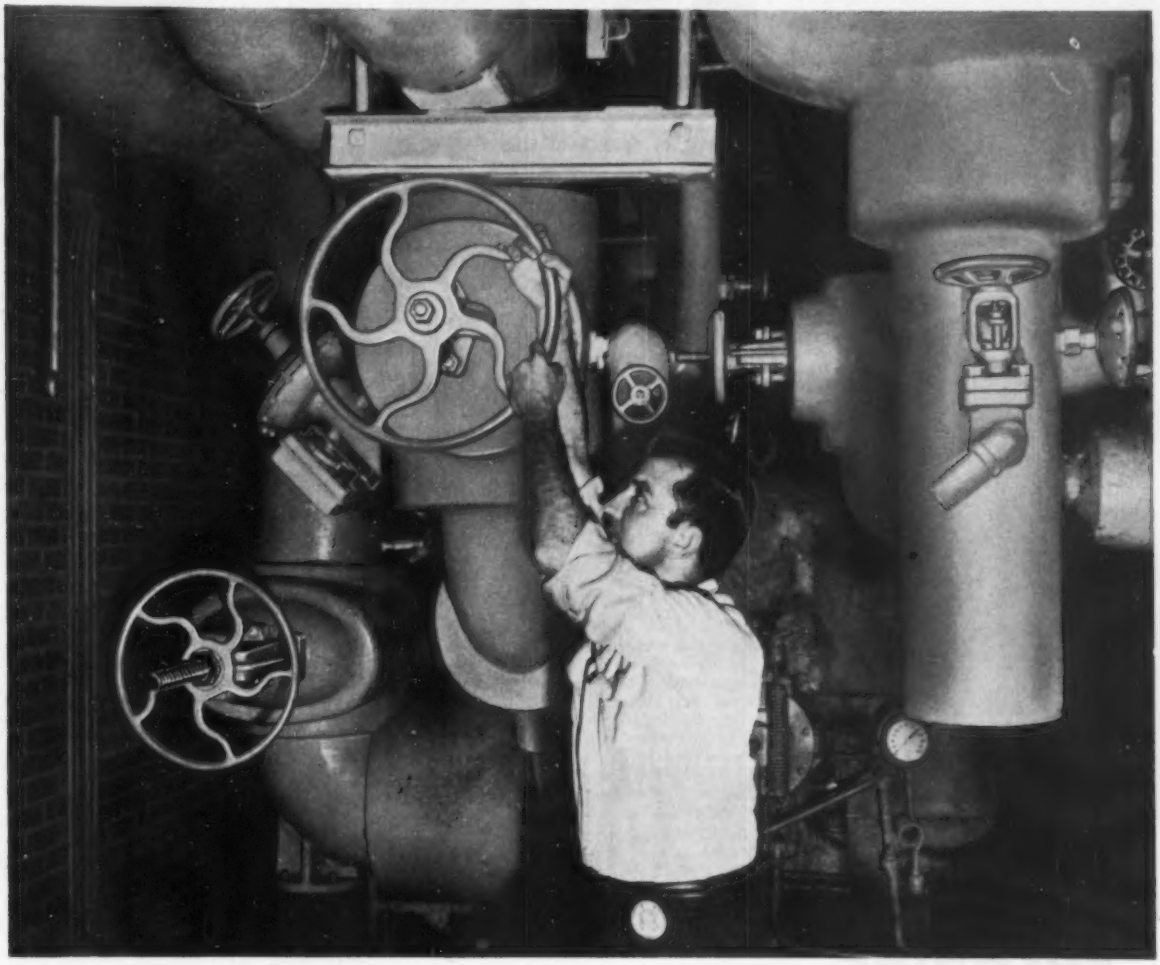
Modern Chemical Processes

"Modern Chemical Processes, Volume 5", contains 14 recently developed chemical processes, all now in operation. Two of these processes are pertinent to the refining industry—"Natural Gas Hydrocarbons for Petrochemicals" and "Dualayer Gasoline Process to Remove Mercaptan".

Descriptions include: *background,* commercial and technical history and origin of present installation; *plant installation,* design details of non-standard items; *process and operation of plant; economics of process,* including raw materials and operating cost breakdowns; *plant investment and amortization; personnel;* and *future prospects.*

(Editors of Industrial and Engineering

Cities Service shows how to cut valve costs



Crane globe valve in 14th year on steam turbine line

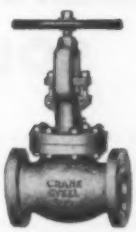
Cities Service Refining Corp. uses hundreds of valves at its Lake Charles, La., plant. Maintenance and replacement costs could be staggering, but for careful control of valve selection.

For example, the Crane 6-inch, 300-pound steel globe valve shown above was installed at the Lake Charles plant 14 years ago. Working at 250 psi., 600 deg. F., the valve is used in the steam line to a turbine-driven feed-water pump.

In spite of its operation 3 or 4 times a week, this sturdy Crane valve has continued tight in service and has required no repairs in 14 years!

Thrifty buyers want no better reward than the kind of cost-cutting, dependable service they get when Crane valves are installed.

That's why in the petroleum industry, as in all industries, you'll find more Crane valves used than any other make.



This is the valve used on installation above. CRANE 151XR, 300-pound cast steel globe valve for 850° F. maximum temp. Sizes: 2 in. to 8 in. For full details, see your Crane Representative, or write to address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

One of the world's most dependable performers—"Old Faithful" Geyser.

in **ALUMINUM CHLORIDE** ***make yours*** **SOLVAY**

You can always depend on the uniformity and purity of SOLVAY's Aluminum Chloride and on SOLVAY's production facilities for prompt deliveries when you need them.

Write today for literature, prices and specific information.

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N.Y.

BRANCH SALES OFFICES:

Boston • Charlotte • Chicago • Cincinnati • Cleveland
Detroit • Houston • New Orleans • New York
Philadelphia • Pittsburgh • St. Louis • Syracuse

New Books . . .

Chemistry magazine, et al, *Modern Chemical Processes, Volume 5*, Reinhold Publishing Corp., Dept. B-189, 430 Park Ave., New York 22, N. Y., 154 pages, $5.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Chemical Publications

"Chemical Publications" is a long-awaited revision of a standard text and reference book which takes into account the many changes that have occurred in chemical literature during the last two decades. It introduces students to the nature and extent of all this literature of chemistry and chemical technology, and gives them personal experience in its use. The strong points of the book are an overall, balanced perspective of chemical publications of various kinds, and library exercises to introduce students to this literature.

(Mellon, M. G., *Chemical Publications*, McGraw-Hill Book Co., Inc., 330 W 42nd St., New York, N. Y., 327 pages, $7.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Vehicle Fire Standard

As a result of several serious fires and explosions involving asphalt tank vehicles, the National Fire Protection Association has amended its standards for flammable liquid tank vehicles to include asphalt.

Special design features as well as operating procedures for asphalt tank vehicles are covered in the specifications, prepared by the NFPA Committee on Flammable Liquids and adopted at the Association's recent annual meeting.

(NFPA Flammable Liquids Committee, *Recommended Regulatory Standard for Tank Vehicles for Flammable Liquids*, National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., $ .40.)

Flammable Liquids Code

Many types of operations, from garages to marine service stations, will be affected by several amendments to the "Flammable Liquids Code" adopted by the National Fire Protection Association at its recent annual meeting.

This standard is the basis of many state and municipal regulations. The amendments were recommended by the NFPA Committee on Flammable Liquids, chairmanned by C. H. Bunn, Jr., of Esso Research and Engineering Co., and one of the non-profit organization's 110 technical committees which prepare the National Fire Codes.

(NFPA, *Flammable Liquids Code*, National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., $.60).

Engineering Economy

"Engineering Economy" provides an understanding of the type of economic study which engineers in industry are called upon to make when considering the functional solution of engineering problems. The book consists of three separate but related analyses—the economy analysis, the intangible analysis, and the financial analysis. The economy analysis attempts to evaluate the value of the project in terms of profit and yield on the investment. The intangible analysis deals with those factors which are influenced by human judgment, while the financial deals with the provision of the funds which make the project possible.

(Bullinger, Clarence E., *Engineering Economy*, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y., 379 pages, $7.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

Petroleum Bibliography

The purpose of "National Petroleum Bibliography" is to present, bi-monthly, a systematic listing of current petroleum titles, grouped under topic headings for maximum ease in locating information sources. Material of both limited and widespread application is included in order to provide a comprehensive spread of data for bibliographical references.

(*National Petroleum Bibliography*, P. O. Box 3586, Amarillo, Texas, published bi-monthly, $35.00 per year.)

Petroleum Terms Defined

The latest revision of the "Standard Definitions of Terms Relating to Petroleum" has been developed and published by the American Society for Testing Materials as ASTM Standard No. D288-57 and approved as American Standard No. Z11.28-1957 by the American Standards Association.

Among the 27 terms defined in the standard are asphalt, crude petroleum, fuel oil, kerosine, and tops.

(ASTM, *Standard Definitions of Terms Relating to Petroleum, No. D288-57*, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., $.30)

Liquefied Petroleum Gases

"Standard No. 58, Liquefied Petroleum Gases," contains new provisions on the location and construction of containers, liquid level gaging devices, exhaust systems and other provisions pertaining to the design, construction and operation of liquefied petroleum gas installations covered in the scope of the standard.

Liquefied Petroleum Gases at Utility Gas Plants, NFPA No. 59, contains many new changes particularly in the portions of the standard on location of containers, installation of storage containers and handling. This standard pertains to the design, construction, location, installation and operation of liquefied petroleum gas systems at utility facilities.

(NFPA Liquefied Petroleum Gas Committee, *Standard No. 58, Liquefied Petroleum Gases*. National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., $ .40)

Fuel Storage Stability

"Accelerated Storage Stability of Aviation Fuels" reveals the wide variations that exist in deterioration rates of different aviation fuels during storage at desert temperatures. Fuels with a number of base stocks were stored in closed containers under a temperature of 130 F. for the test.

Phenylene diamine was shown to be a more effective inhibitor than trialkyl phenol. It was concluded that the stability of fuels varies according to base stock composition. C_2 and C_4 alkylate base stocks appeared to withstand deterioration better than straight-run fuels.

(Sneed, R. W., Ballentine, O. M., and Winterhaulter, J. H., *Accelerated Storage Stability of Aviation Fuels, PB 131369*, Office of Technical Services U. S. Department of Commerce, Washington 25, D. C., $1.00)

Says Maintenance Foreman of large gas processing plant.

W-K-M's new acf® non-lubricated BALL VALVE

This new product of W-K-M's *Creative Engineering* has been service-proved with these ladings.

Acetate · Crude ammonia liquor · Aviation fuel and Stoddard solvent · Propane · Toluol · Methylethylketone (MEK) · Alkaline slurry · Jet engine fuel (test cells) · Naphtha and coal tar solvents · Paint cleaner and thinner · Liquid soaps, DDT and chlordane · Vinyl chloride · Butadiene liquid · Copper ammonium acetate · Carbon bisulphide · Cleaning naphtha · Lime and soda ash slurry · Riboflavin media · Gasoline (tank truck) · Helium gas · Coke oven by-product gas · Gasoline (tank car) · Chlorinated solvents.

For 3½ years, users tested this new valve in the hardest services that could be found.

Now, W-K-M offers it to you as a **service-proved** new product, a new product with no bugs, a typical example of W-K-M's leadership in design, production and service.

This valve will deliver promised performance; you can specify it with complete confidence in its efficiency, economy, ease of operation and maintenance.

You should know more about it.

Write for Catalog 1000 for complete information.

AVAILABLE in carbon steel (ASA 150 lb., 300 lb.), and semi-steel (200 lb. WOG, 400 lb. WOG); sizes range from ½" through 6". Also ASA 600 lb., sizes ½, ¾ and 1".

W-K-M

DIVISION OF acf INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

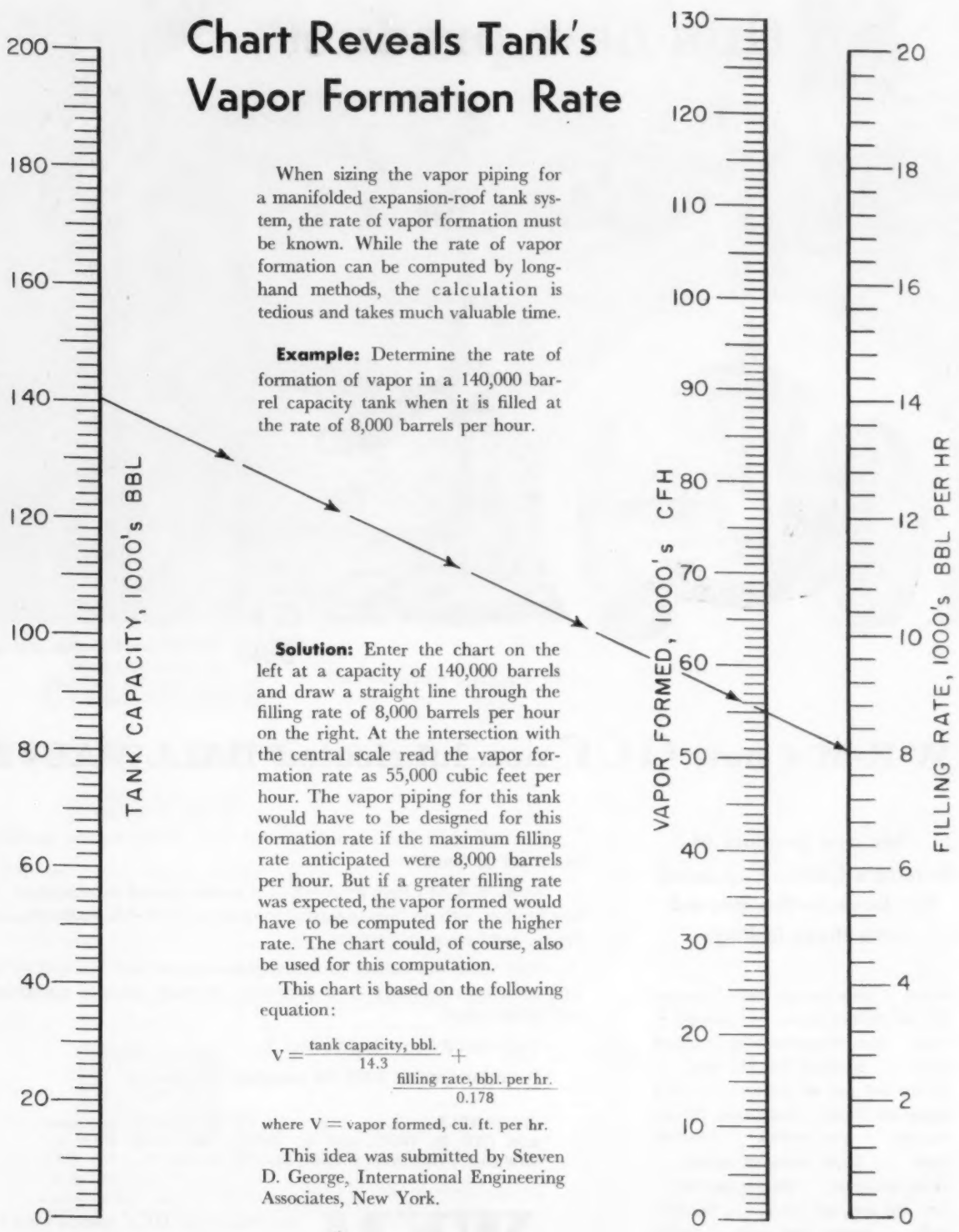
5012

How To Do It . . .

Chart Reveals Tank's Vapor Formation Rate

When sizing the vapor piping for a manifolded expansion-roof tank system, the rate of vapor formation must be known. While the rate of vapor formation can be computed by longhand methods, the calculation is tedious and takes much valuable time.

Example: Determine the rate of formation of vapor in a 140,000 barrel capacity tank when it is filled at the rate of 8,000 barrels per hour.



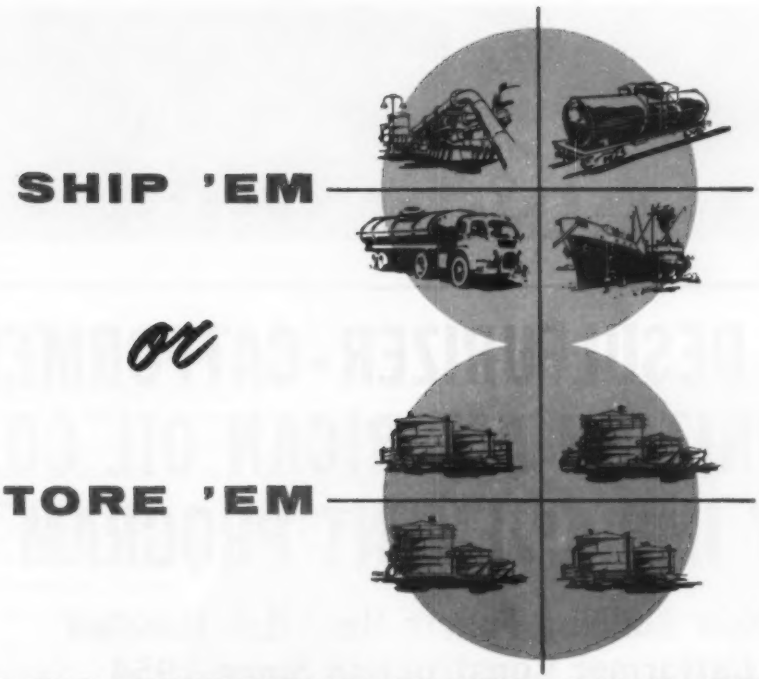
Solution: Enter the chart on the left at a capacity of 140,000 barrels and draw a straight line through the filling rate of 8,000 barrels per hour on the right. At the intersection with the central scale read the vapor formation rate as 55,000 cubic feet per hour. The vapor piping for this tank would have to be designed for this formation rate if the maximum filling rate anticipated were 8,000 barrels per hour. But if a greater filling rate was expected, the vapor formed would have to be computed for the higher rate. The chart could, of course, also be used for this computation.

This chart is based on the following equation:

$$V = \frac{\text{tank capacity, bbl.}}{14.3} + \frac{\text{filling rate, bbl. per hr.}}{0.178}$$

where V = vapor formed, cu. ft. per hr.

This idea was submitted by Steven D. George, International Engineering Associates, New York.



NALCO-TREATED FUEL OILS STAY FRESH!

Get rid of the hurry-up-and-sell pressure caused by unstable fuel oils that darken and sludge up when stored or shipped any distance. New Nalco 303-AC is the fuel oil dispersant-stabilizer that gives you *best* control of sludging tendencies—keeps fuel oils refinery-fresh, bright, and sludge-free even when shipped thousands of miles and stored for months.

Ask for product information on this new chemical for distillate fuels. It is available promptly from your Nalco Representative, or from Nalco direct.

NATIONAL ALUMINATE CORPORATION 6259 West 66th Place, Chicago 38, Illinois

Northwestern United States, Hawaii and Alaska: The Flox Company, Inc., Minneapolis 3, Minnesota
Canada: Alchem Limited, Burlington, Ontario • Italy: Nalco Italiana, S.p.A. • Germany: Deutsche Nalco-Chemie GmbH • Spain: Nalco Espanola, S.A.

Fuel oil at *left* is fresh from refinery, bright and clear. *Center*, Nalco-treated oil is bright and sludge-free after four months. *Right*, untreated sample in four months time has darkened considerably, already begun to sludge.

Nalco®
PRODUCTS

SERVING THE PETROLEUM INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

For more data on advertised products, use Readers' Service Cards, last page.

LUMMUS

ENGINEERS AND CONSTRUCTORS

385 Madison Avenue

FOUR NEW DESULFURIZER-CATFORMERS PART OF BRITISH AMERICAN OIL CO.'S QUALITY IMPROVEMENT PROGRAM

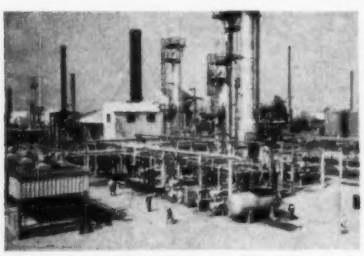
Lummus Now Building Fourth Unit: Has Handled All B-A Catformer Construction Since 1954

Since 1954 the British American Oil Company has authorized several million dollars worth of desulfurizer-Catformer units at four refineries throughout Canada as part of their quality improvement program, which is designed to produce a higher octane gasoline for industrial and consumer use.

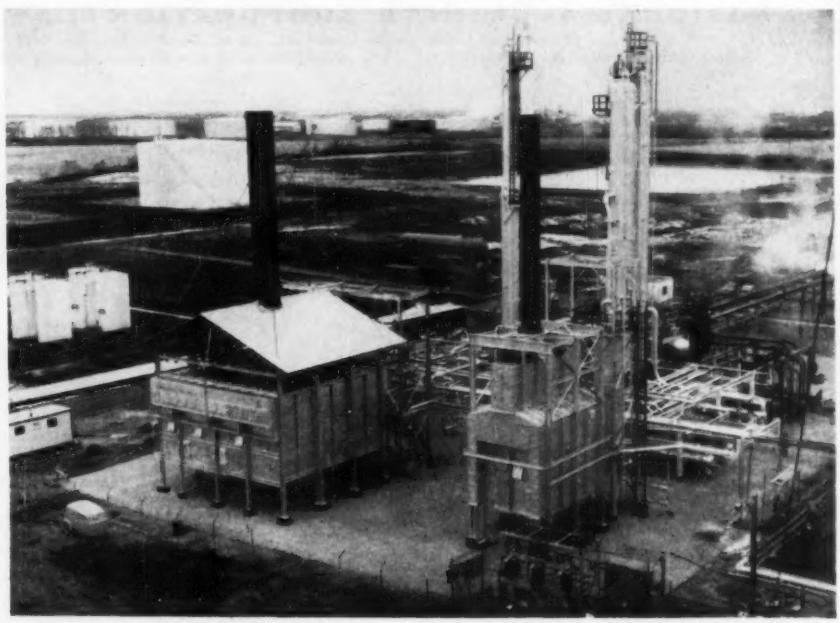
These facilities, engineered and constructed by The Lummus Company Canada Limited, have been completed at Montreal East, Quebec; Clarkson, Ontario; and Edmonton, Alberta. A fourth facility at Moose Jaw, Saskatchewan has been awarded to Lummus and is scheduled for completion by October, 1958.

The Edmonton Catformer, with a capacity of 5,400 B/D, cost

Montreal-East Catformer has 13,000 B/D capacity. Cost is $2 million. Completed early 1955.



Clarkson, Ontario Hydrodesulfurization Catformer cost $2,300,000, has 10,000 B/D capacity. Completed summer of 1957.



Shown is the record-breaking Catformer construction job at Edmonton, Alberta for The British American Oil Company. Completed in mid November 1957, this is the third Catformer engineered and constructed by Lummus for B-A. Since then a fourth unit to be completed by October 1958 is under construction for B-A by Lummus.

For more data on advertised products, use Readers' Service Cards, last page.

FOR INDUSTRY

New York 17, N. Y.

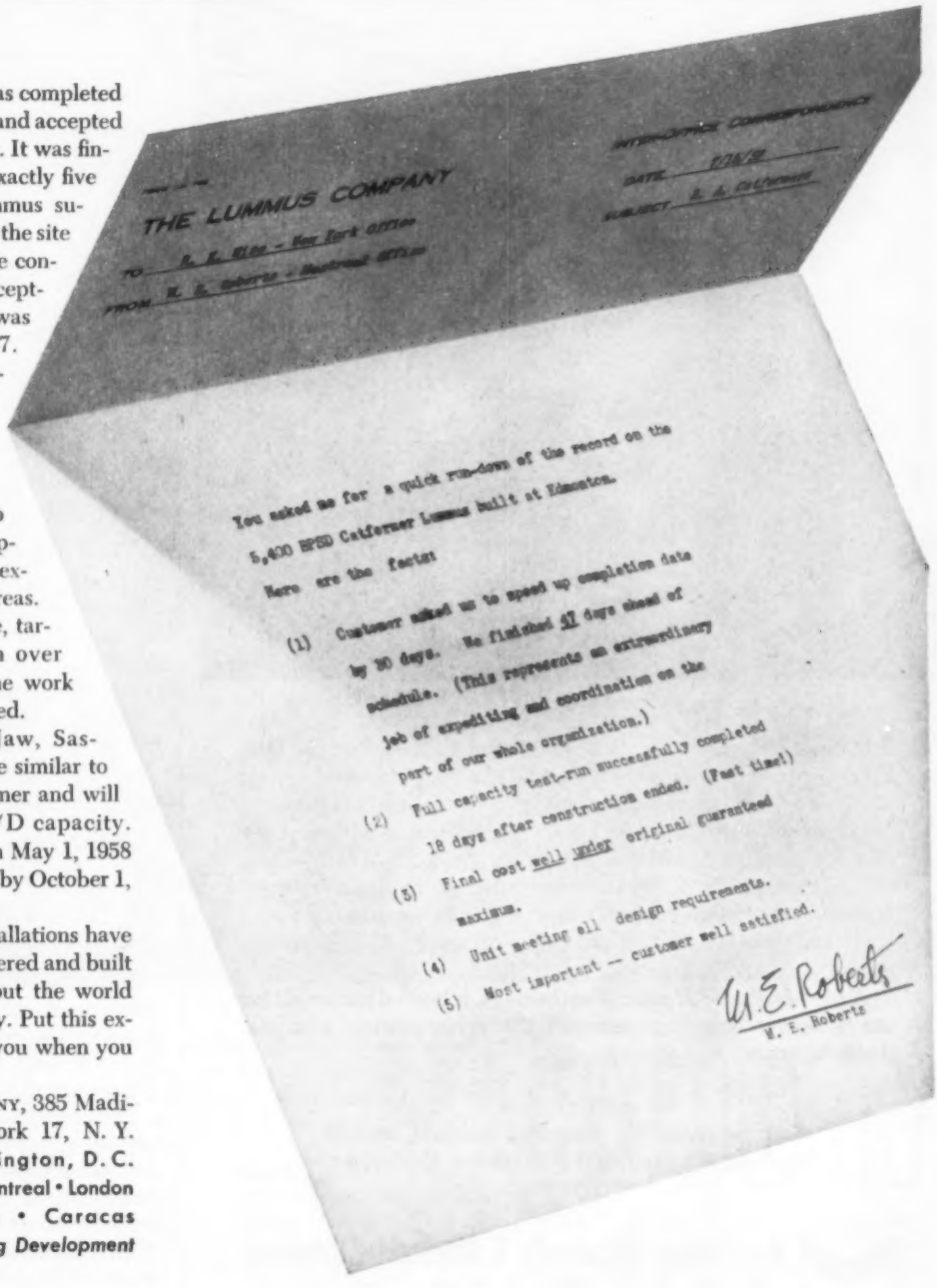
$2,100,000. The Unit was completed on November 15, 1957, and accepted by B-A two weeks later. It was finished in record time—exactly five months after the Lummus superintendent arrived at the site and 11 months after the contract was awarded. Acceptance by the customer was on December 3, 1957.

A potentially crippling snowstorm at the site in early October was anticipated by Lummus field engineers, who had temporary steel supports erected over the exchanger and piping areas. When the snows came, tarpaulins were thrown over these supports and the work continued uninterrupted.

The new Moose Jaw, Saskatchewan unit will be similar to the Edmonton Catformer and will also have a 5,400 B/D capacity. Construction began on May 1, 1958 and will be completed by October 1, 1958.

Over 800 major installations have been designed, engineered and built by Lummus throughout the world in the last half-century. Put this experience to work for you when you plan new facilities.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y.
New York • Washington, D.C. Chicago • Houston • Montreal • London Paris • The Hague • Caracas Maracaibo. *Engineering Development Center:* Newark, N. J.


THE LUMMUS COMPANY

INTEROFFICE CORRESPONDENCE

DATE 10/6/58

SUBJECT E. E. Columbus

TO E. E. Ellis - New York office

FROM W. E. Roberts - Montreal office

You asked me for a quick run-down of the record on the 5,400 BPSD Catformer Lummus built at Edmonton.

Here are the facts:

(1) Customer asked us to speed up completion date by 30 days. We finished 47 days ahead of schedule. (This represents an extraordinary job of expediting and coordination on the part of our whole organization.)

(2) Full capacity test-run successfully completed 18 days after construction ended. (Fast time!)

(3) Final cost well under original guaranteed maximum.

(4) Unit meeting all design requirements.

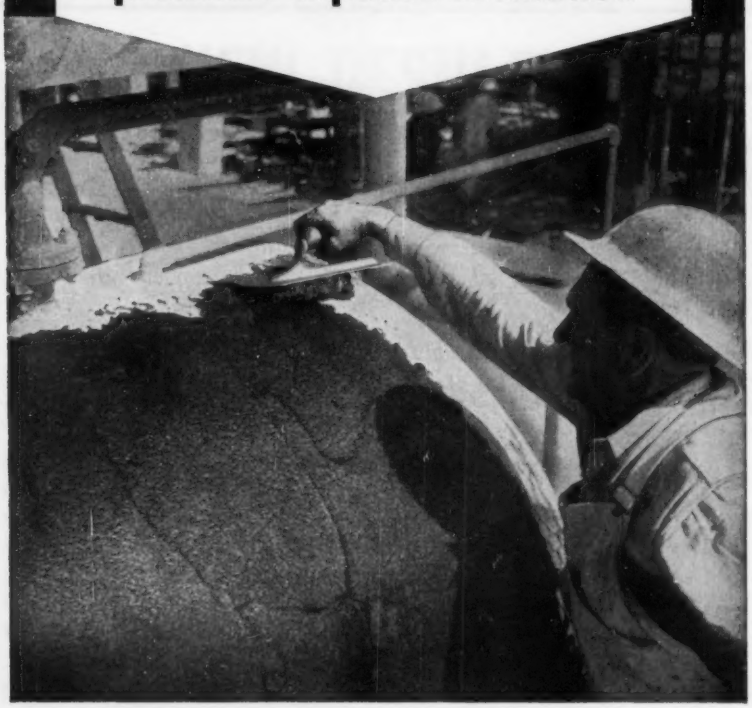
(5) Most important — customer well satisfied.

W. E. Roberts

W. E. Roberts

For more data on advertised products, use Readers' Service Cards, last page.

Laykold® WEATHERCOAT
protects exposed insulation



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

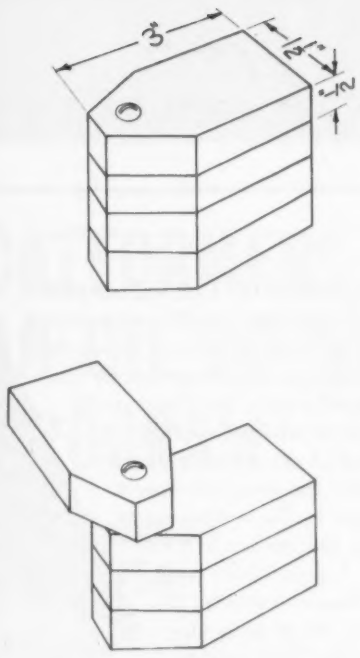
A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

American Bitumuls & Asphalt Company

320 Market St., San Francisco 20, California
Baltimore 3, Md. · St. Louis 17, Mo. · Perth Amboy, N. J.
Mobile, Ala. · San Juan 23, P.R. · Cincinnati 38, Ohio
Inglewood, Calif. · Oakland 1, Calif. · Tucson, Ariz.
Portland 7, Ore.

How to Do It...



Step Blocks For Drill Press Made From Plate

Drill press work frequently needs a small amount of blocking for ease in drilling.

An easy way to provide this blocking is to cut several pieces, as shown, out of one-half inch steel plate. The pieces are then loosely bolted together for ease in handling.

This idea was submitted by Jack O. Evans, E. I. du Pont de Nemours and Co., Inc., Victoria, Texas.

Match Valve Packing to Color Code on Flange

Installing the wrong packing in a valve invariably leads to poor valve service. The results are leaks which not only look bad but can cause a fire or loss of the product.

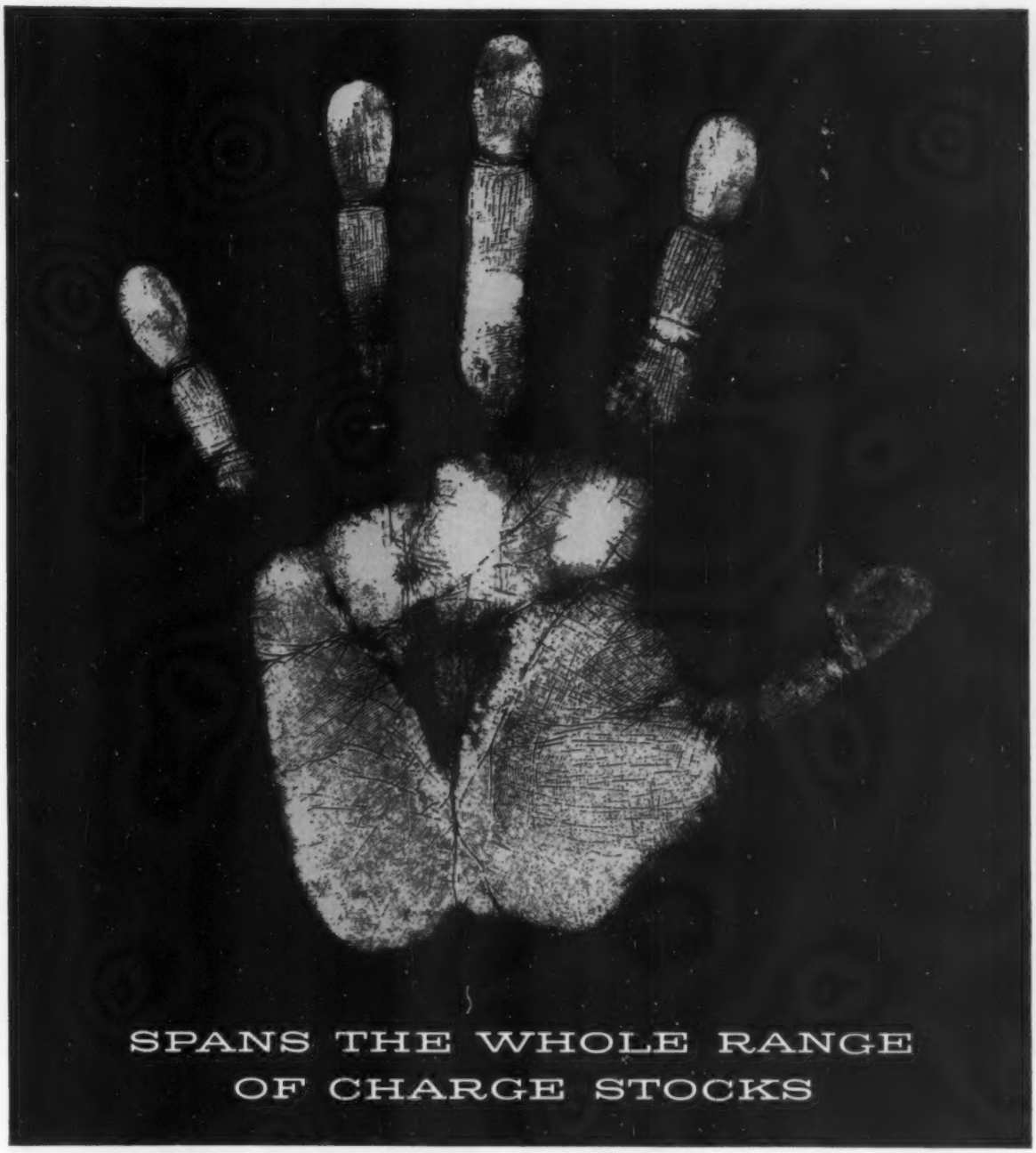
A sure way to identify the valve service is to color code the valve bonnet flanges according to the process condition.

Our refinery code reads:

Red Ribbon—Packing must withstand chemical service.

Silver Ribbon—Packing must withstand high temperature service up to

For more data on advertised products, use Readers' Service Cards, last page.



For the profitable production of high-octane gasoline, select either HOUDRIFLOW to catalytically crack any distillate fraction . . . HOUDRESID to catalytically crack full crudes, distillate fractions or any residual fraction. Either can handle sweet or sour stocks . . . feed ranging from all liquid to all vapor.

HOUDRIFLOW and HOUDRESID each work well with Houdry Mineral Kaolin, a natural cracking catalyst offering high activity, fine sulfur resistance, and superior regenerability and thermal stability.

It will be to your advantage to investigate HOUDRIFLOW, HOUDRESID and Houdry Mineral Kaolin for your particular requirements.

*

HOUDRY
PROCESSES

*Houdry means Progress . . . through Catalysis

HOUDRY PROCESS CORPORATION, 1528 WALNUT STREET, PHILADELPHIA 2, PA.

For more data on advertised products, use Readers' Service Cards, last page.

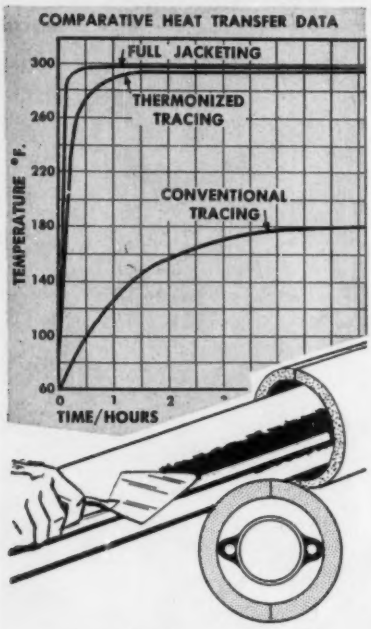
HAVE YOU TRIED

? THERMON ?

Thoroughly proved

HEAT TRANSFER MEDIUM

now effecting savings up to 90% for over 700 users!



Thermon is a non-metallic plastic compound with highly efficient heat transfer properties, and is easily applied over either steam traced or electrical resistance systems . . . working equally well for either heating or cooling processes.

Thermonizing has excellent heat transfer characteristics (see curves), exceeding steam traced equipment approximately 1100%, and closely approaching jacketing equipment. Thermon can be used almost without exception in place of expensive jacketing (and in many applications where jacketing is impossible), with savings up to 90%.

Write for complete technical literature on revolutionary Thermon!

THERMON
THERMON MANUFACTURING CO.
1017 Rosine • P. O. Box 1961
Houston, Texas

101

How to Do It . . .

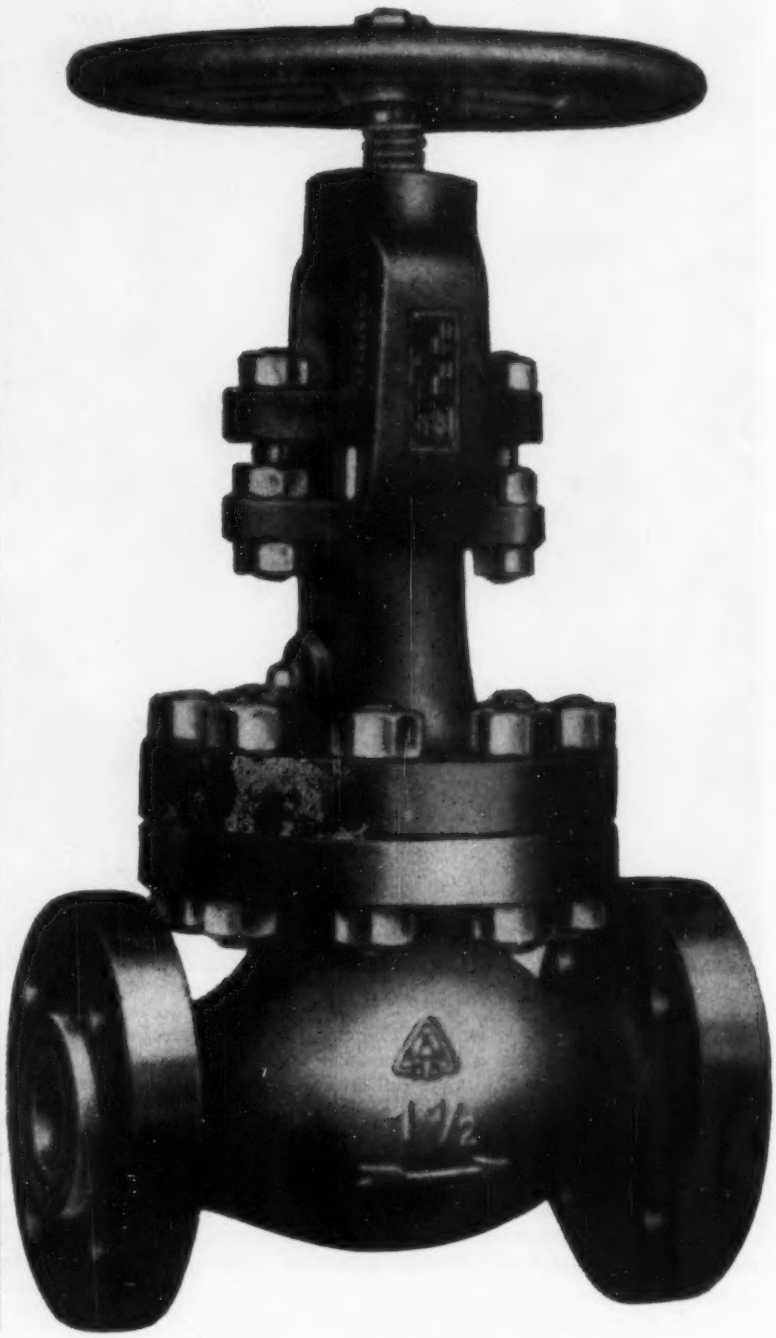
500 F. against steam, crude, etc.

Green Ribbon—Packing must withstand medium temperature service (below 350 F.) against steam, water, air oil, etc.

Yellow Ribbon—Packing must withstand gasoline service, solvents, light distillates, etc.

The maintenance crews, whether in the field or shop, will always replace the packing with another that is correct for the valve service.

This idea was submitted by Tzen-yung Yang of Chinese Petroleum Corp., Kaohsiung, Taiwan.



Approximate Service Limit Brand
3200°F. Castolast (Castable)
3100°F. H-W High Alumina Castable
Apache (Plastic Fire Brick)
3000°F. Chromepak (Casting Mix)
H-W Super Plastic Fire Brick
Apache G (Plastic Fire Brick with Graphite added)
2900°F. H-W Black Patch (Plastic Fire Brick)
2800°F. Harcast (Castable)
2700°F. H-W Super Castable
2600°F. H-W Lightweight Castable 2600
Harchrome (Castable)
H-W Chrome Castable
2500°F. H-W Standard Castable
H-W Periklase Castable
H-W Baffle Mix (Castable)
2400°F. H-W Extra Strength Castable
2300°F. H-W 85 Lightweight Castable
2200°F. H-W 56 Low Iron Castable
H-W 56 Lightweight Castable
1800°F. H-W 25 Lightweight Castable
1500°F. H-W Castable RC

The complete series of HARBISON-WALKER PLASTIC and CASTABLE REFRACTORIES

can assure the proper selection for maximum life and economy

In addition to the wide range of service temperature limits as here illustrated, these monolithic refractories possess the many different combinations of physical and chemical properties needed for best protection against widely diversified destructive factors. From these brands the best balanced selection can be made for adequately withstanding the most severe operating conditions. Some examples of the many destructive influences against which maximum resistance is needed, are: corrosion by slags, fuel ash and various other fluxes; thermal shock; disintegrating action of gases; erosion by molten metals and slags; mechanical stresses at the high working temperatures.

To help secure maximum service from these refractories, Harbison-Walker freely offers engineering service, recommendations based upon wide experience, and quality-controlled products.

HARBISON-WALKER REFRACTORIES CO.
AND SUBSIDIARIES GENERAL OFFICES: PITTSBURGH 22, PA.
World's Most Complete Refractories Service

TYPICAL FURNACE APPLICATIONS: ARCHES • ASH PITS • BOILER SETTINGS • BREECHINGS • BURNER BLOCKS • BAFFLES • CATALYTIC REACTORS • DOOR LININGS • DUCTS AND PIPING • HEARTHS • INSULATION • KILNS AND CARS • LADLE LININGS • ROTARY KILN CHAIN SECTIONS • SOAKING PIT COVERS

Every Step of the way

THE MOST COMPLETE GUARANTEE IN THE FLANGE & FITTING INDUSTRY

Take off and go fishing! — Your OTM flanges guarantee you trouble-free performance — free from worry about flange failure. Specify OTM Blue Ribbon and relax!

A Symbol of Quality and Service — EST. 1919

Your BLUE RIBBON GUARANTEE

Each OTM product is guaranteed to be free from manufacturing defects. If failure occurs within one year after shipment, any OTM product will be replaced without charge when the following conditions have been met:

Provided it has been used as recommended and within A.S.A. and A.G.A. specifications and in accordance with recognized practices.

When the product is to be welded, provided it has been welded in accordance with recognized practices and within such Standards as A.S.M.E. and A.W.S. Codes.

Provided it has not been worn out due to severe operating service, such as is encountered under extremely corrosive, abrasive or acid conditions which the steel was not made to withstand.

OTM Corporation will pay all transportation charges and any necessary expense incurred to remove and replace any OTM product proved to be defective.

This is the broadest and most specific guarantee in the industry. You are CERTAIN of the superior performance of BLUE RIBBON PRODUCTS!

If you believe any OTM product to be defective, regardless of how minor the problem may be, call Mr. Kenneth H. Bradshaw collect (person to person) before making any final decision.

A Symbol of Quality and Service — EST. 1919

OTM CORPORATION

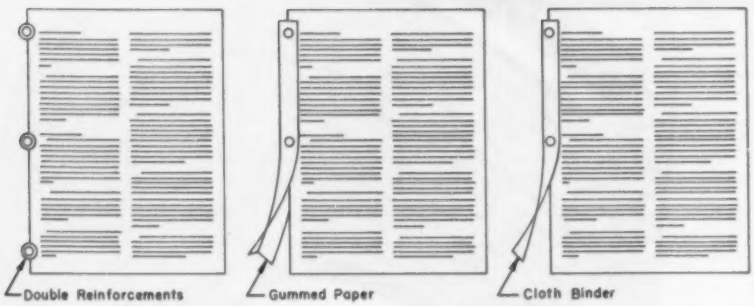
7430 KATY HWY. • P. O. BOX 19296
HOUSTON 24, TEXAS

Available through authorized distributors only!

OTM CORPORATION

P. O. BOX 19296	HOUSTON 24, TEXAS	UN 2-6643
3110 BLOSSOM LANE	ODESSA	PHONE: EMerson 6-8011
316 CLAIBORNE TOWERS	NEW ORLEANS	PHONE: RAymond 7721
P. O. BOX 1776	TULSA	PHONE: LUther 5-5182
NEW YORK, N. Y.		DALLAS, TEXAS
DENVER, COLO.		LOS ANGELES, CALIF.

How to Do It . . .



It's Easy to Fix Those Perforated Pages

If you're a clipper of PETROLEUM REFINER articles for filing in notebooks, maybe you've been frustrated by the narrow margins resulting from perforated pages. Sometimes, they are so narrow that you have to punch into the text in order to make holes that fit your notebook. Here are three ways to end your frustrations:

Cantilever Principle. Use double reinforcements, back to back, placed with the edge of the perforated sheet running through the center of the reinforcements. This method is fast and no punching of the sheets is required.

Edge Treatment. Get a roll of ordinary 1¼-inch wide, brown paper tape. Cut a strip 11 inches long, fold down the center, moisten and fasten to the perforated edge. A paper punch completes the job by making holes to fit your notebook.

Alternate Edge Treatment. Cloth impregnated tape, ½ inch wide, can be fixed to a ⅛-inch strip along the perforated edge, via a rubber tipped glue bottle. Holes may then be punched to fit your ring binder.

Chain Operated Valve For Emergency Fuel Cutoff

When it is necessary to have a valve which will cut off the main fuel line in case of an emergency, a plug valve may be placed just outside the station door as shown. The valve handle is made from a piece of scrap metal which has been cut out by the welder to fit the end of the plug. The ends of the lever are drilled and a short length of chain fastened to each end. The square in the middle is made at an angle so that the lever is normally in a 45 degree position when open or closed.

In case it is desired to cut off the entire fuel supply, it is only necessary for the operator to come out the door or down either side of the building and feel for the chain nearest the corner. One yank does the trick. As soon as it is desired to return the line to service, it is only necessary to pull the other end of the chain and the valve is opened again.

This idea was submitted by Harry Hess, Houston.

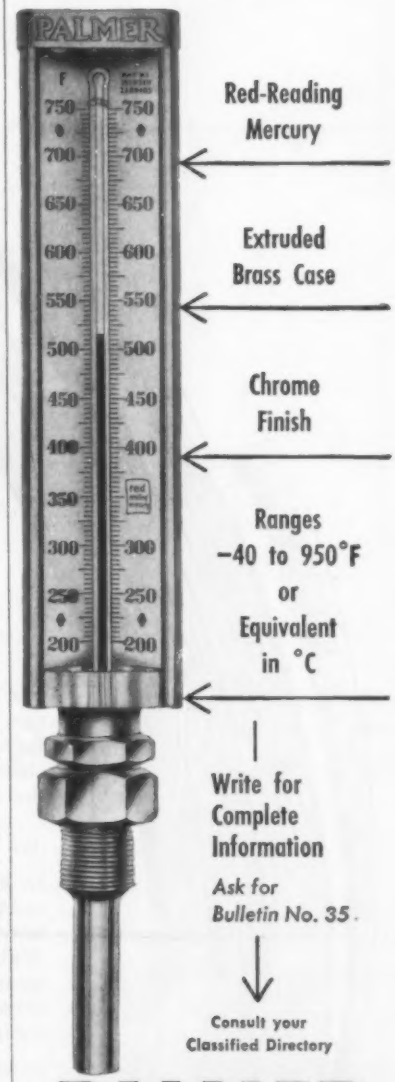
YOUR IDEAS ARE VALUABLE!

At least $10 will be paid for each idea accepted for "How to Do It."

Today's Modern Industry
Demands a Modern Thermometer

PALMER

RED-READING MERCURY THERMOMETERS



Write for Complete Information

Ask for Bulletin No. 35.

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

Cincinnati 12, O.

For more data on advertised products, use Readers' Service Cards, last page.

PUT FLEXITALLIC IN THE "PRINTS"

For Sealing Performance You Can Depend On

For nearly fifty years, there has been one uniquely resilient seal with a spring-action that adjusts to every change in operating conditions. It's the Flexitallic Spiral-Wound Gasket . . . identified for engineers by the blue dye in the Canadian asbestos filler.

In Flexitallic Spiral-Wound Gaskets, compression response is directly related to bolting for each application. With the desired gasket design determined, exacting mechanical controls assure that manufactured gaskets conform to specification.

Flexitallic Spiral-Wound Gaskets serve under the most rigorous operating conditions — from vacuum to 6,000 lbs., from extreme sub-zero to 2000°F. The amazing flexibility of the Flexitallic Gasket makes flanged joints leak-proof even after severe thermal shock, vibration, chemical attack, and cyclic operation.

That's why: for sealing performance you can depend on, it pays to put "Flexitallic" in the blueprints.

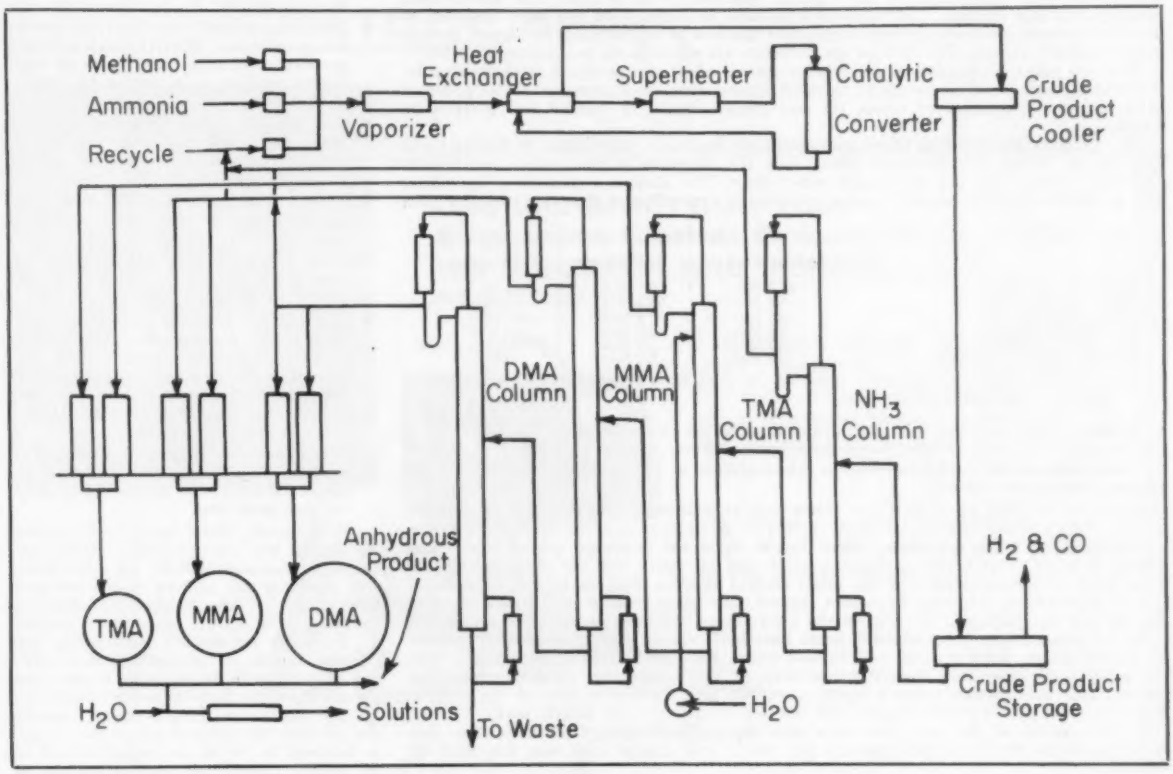
FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered tradename. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler

Who's Building . . .



The new plant will produce methylamines by reacting menthanol and ammonia.

Now A New Methylamines Plant for CSC

Commercial Solvents begins production with an Indiana plant of a streamlined process design

A new methylamines plant has now gone into full scale production at the Commercial Solvents Corp. plant at Terre Haute, Ind. The complete basic process design for the plant and equipment was provided by J. D. Leonard & Associates. Detailed engineering and general contracting of construction was handled by the engineering department of Commercial Solvents Corp., using local contractors to perform the actual plant construction.

The plant design incorporated process features from work both in the U. S. and foreign countries. European plants in some cases use batch type plants which produce mixtures of the amines rather than pure products. In the U. S., plants now in operation are all continuous. Some utilize low-pressure synthesis and distillation systems and these systems require many more pieces of equipment, and have other disadvantages chief of which is the inability to recycle unwanted excess product.

Completion of this plant is of especial interest now because of major new uses that have been developed for the methylamines in several of the new missile fuels, new organo-metallic compounds, new insecticides now in final phases of field testing, and new photographic chemicals.

If the new missile fuels using these amines are mass produced for defense purposes, the U. S. capacity for methylamines will not be adequate to meet the needs which have been esti-

mated to run as high as 50-million pounds per year of DMA. However aside from possible defense needs, the new plant does give a needed boost to present U. S. capacity, and will undoubtedly encourage the development and marketing of other new amine-based products. In this respect, it is interesting to note that the plant has been designed to produce material satisfying the requirements of the new products being developed, as well as established products. The fulfilled specifications are noted in the accompanying table.

The new plant is classified as a synthetic organic plant and produces methylamines by reacting methanol and ammonia at elevated temperatures and pressures in the presence of a catalyst. A mixture of mono, di, and trimethylamine is formed and purified by distillation.

The plant is divided into three main sections: Synthesis, Distillation & Storage, and Blending & Filling. The complete plant, with the exception of the control instruments and drum filling lime, may be located out-of-doors. The plant is a continuous operation, and is completely instrumented and automatically controlled so that one operator plus

	Mono-Product	Di-Product	Tri-Product
MMA, Percent Weight	97.8 Min.	0.1 Max.	0.1 Max.
DMA, Percent Weight	0.4 Max.	98.5 Min.	0.1 Max.
TMA, Percent Weight	0.8 Max.	0.4 Max.	98.8 Min.
NH_3, Percent Weight	0.0 Max.	0.0 Max.	0.0 Max.
H_2O, Percent Weight	1.0 Max.	1.0 Max.	1.0 Max.
Formaldehyde, Percent Weight	0.0 Max.	0.0 Max.	0.0 Max.

Solutions to be water white and clear.

a day-time utility operator can control and operate the complete plant. On page 373 is the flowsheet of a typical continuous methylamine plant; a number of different separation methods may be used depending on the conditions at a given plant location, and tht product distribution desired.

Space in the CSC plant at Terre Haute was at a premium, so that the streamlined process design which eliminated many pieces of equipment used in older plants, permitted CSC to make a compact plant layout to fit the available space. Supervisory offices, a small control lab, a shipping office and lavatory, and the electrical control room have all been combined in this single control building designed by CSC. Combination of supervision, shipping, in-process control, and plant control in a single building has obvious cost savings over older plants where these functions are handled separately.

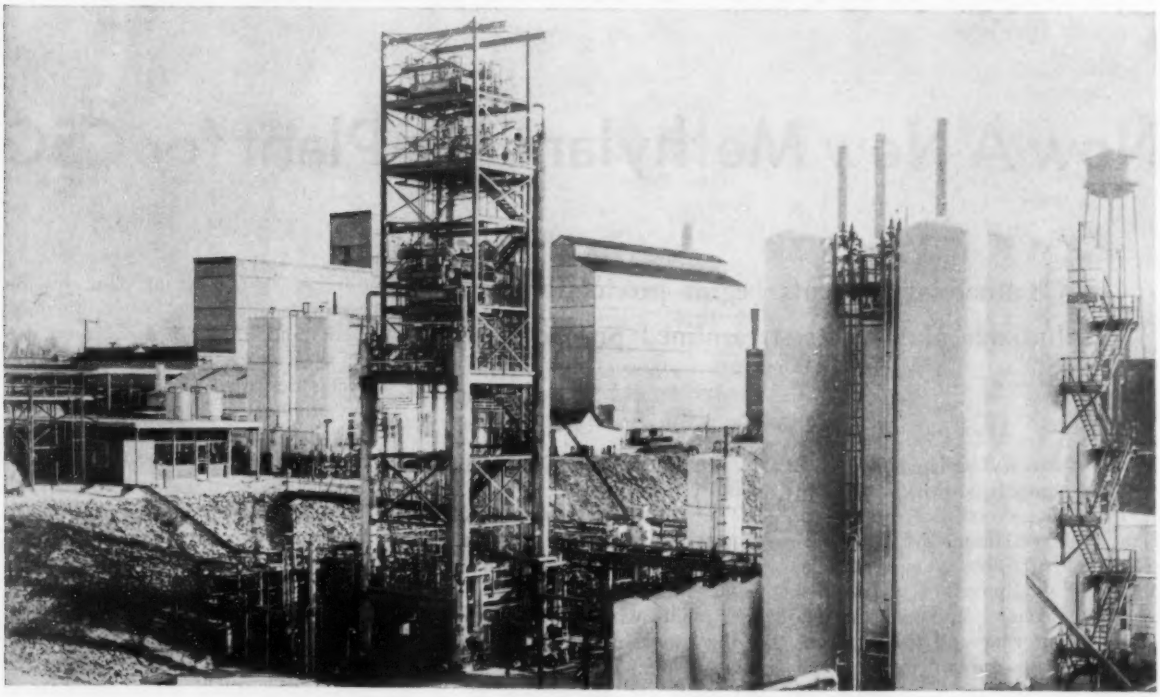
In this plant, flanged and screwed joints have been almost entirely eliminated in favor of welded joints. Even manual and control valves have been welded permanently into the piping, allowing only flanged connections at the equipment, or spare-connection points. This construction reduces piping cost, but also eliminates most of the leakage found in older plants where flanged and screwed connections are largely used.

While capacity of the new plant is a carefully guarded secret, CSC does state that it is "in excess of five million pounds per year," and capital cost was less than $2 million.

A summary of the process design features of the plant shows:

- Equilibrium synthesis system allows recycle of any excess product without loss, thus giving complete flexibility to meet varying, seasonal demands for the three products.
- The consolidated distillation system using only four distillation columns permits continuous production of high purity product with automatic instrument control.
- New design of the synthesis system eliminates many pieces of equipment, simplifies automatic instrument control, and improves conversions.
- Complete instrumentation permits automatic control of the entire operation with only one operator.
- Welded piping plus scrubbing of all vent gases eliminates odors and improves yields.
- Elimination of many pieces of equipment in the new process design permits a compact layout which utilizes less ground space, and reduces piping, wiring, instrument runs, and reduces cost of painting, insulation, foundations, and other construction costs.
- Continuous production of high purity product permits meeting the requirements for both new products and present day products.

So far as the future is concerned, it can be certain that these highly reactive, and versatile materials will be used in countless products still unborn in the research laboratories of the world-wide chemical industry. The exact capacity of present U. S. plants are not for publication, and existing figures of production show only the material sold on the open market and do not show the large quantities consumed by the producers. Present total capacity for all three products of acceptable purity, is believed to be in the neighborhood of 30 million pounds per year. Obviously, if



Steamlined design permitted Commercial Solvents' plant to fit available space.

You can't eliminate maintenance but you can

reduce maintenance time and costs with efficient AIRETOOL equipment

Use this AIRETOOL Tube Expansion Control System to roll tubes fast with positive accuracy

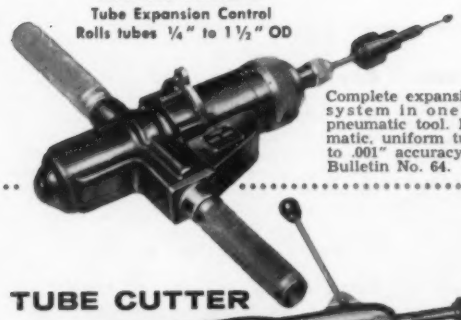
Just preset the control and expansion stops automatically assuring uniform tightness. Leaks and distortion of tubes and tube sheet are positively eliminated. Rolling time is greatly shortened . . . tube life increased.

Control used for tube sizes ½" to 2½". Four motor sizes to meet your power requirements.

CONTROL No. 113-15

AIRETROL

Tube Expansion Control
Rolls tubes ¼" to 1½" OD

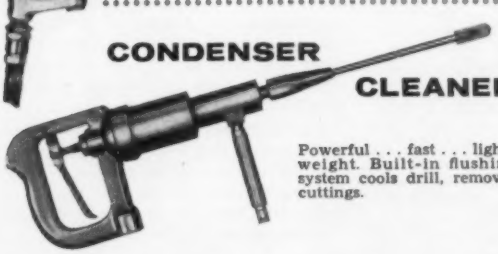


Complete expansion control system in one compact pneumatic tool. Fast, automatic, uniform tube rolling to .001" accuracy. Send for Bulletin No. 64.

TUBE CUTTER

Cuts tubes fast and easy without gouging or burning. Positive feed control. Air or electric operated.

CONDENSER CLEANER



Powerful . . . fast . . . lightweight. Built-in flushing system cools drill, removes cuttings.

Consult AIRETOOL on any tube maintenance problem

Through more than 28 years of developing improved tools and techniques in tube maintenance Airetool has accumulated a great deal of knowledge which they will gladly share. Ask your Airetool representative or write direct for immediate assistance on any tube maintenance problem.

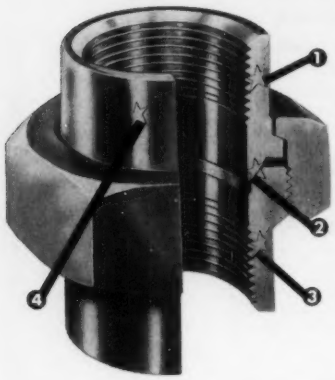
See the big 24 page AIRETOOL catalog in your Refinery Catalog

BRANCH OFFICES
New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

REPRESENTATIVES in principal cities of U.S.A., Canada, Mexico, Puerto Rico, South America, Hawaii, England, Italy, Europe, Japan.
CANADIAN PLANT: Brantford, Ontario
EUROPEAN PLANT: Vlaardingen, The Netherlands

For more data on advertised products, use Readers' Service Cards, last page.

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

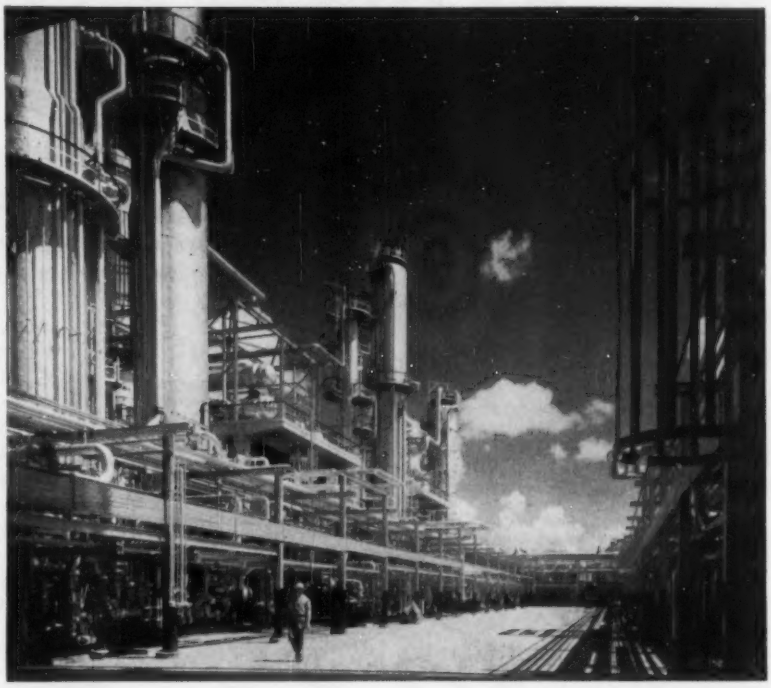
for complete, guaranteed satisfaction

. . . always specify
CATAWISSA

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA

Who's Building . . .

missile fuels result in defense needs of 50 million pounds per year, present producers will find themselves "on the ground floor" of what could prove to be a very exciting future.



New Alky Unit for Magnolia Petroleum

Magnolia Petroleum Co.'s new high-octane alkylation unit at its refinery in Beaumont, Texas, went "on stream" recently producing 8,000 bpd. Second of its kind at the modern 1,500-acre refinery, the unit occupies roughly an area the size of a city block, complete with alleyways of its own as shown above. Tallest of the unit's three fractionation towers looms about 16 stories above the ground.

The Anatolian Petroleum Refinery Co., owned by British Petroleum, California Texas Corp., Mobil Overseas Oil and Royal Dutch Shell, has applied for permission to build an oil refinery at Mersin, in Southern Anatolia, with a capacity of 3.2 million tons annually, about 60,000 bpd.

The refinery is expected to be put into operation in 1962.

The Kenya Government announced its support for a major oil refinery project at Mombasa. The announcement follows talks between Kenya's governor and minister of commerce and industry, and top management of the Royal Dutch Shell group of companies.

The government would continue to afford every possible facility to the Shell group in connection with the Mombasa project.

The Shell group, while unable to commit themselves at present, believed that their interests might at some future date require the construction of a refinery at Mombasa.

The statement added that the timing of any project if proceeded with any other matters in connection with it would be discussed at an appropriate time with the Kenya government.

Royalite Oil Co., Ltd., has placed a new platforming unit for production of high octane gasoline blending component on stream at Kamloops, B. C. It has a design capacity of 1,000 bpsd, and is processing a naphtha, derived from Trans Mountain Pipeline Light Blend Stream crude, which boils at 180 to 400 F.

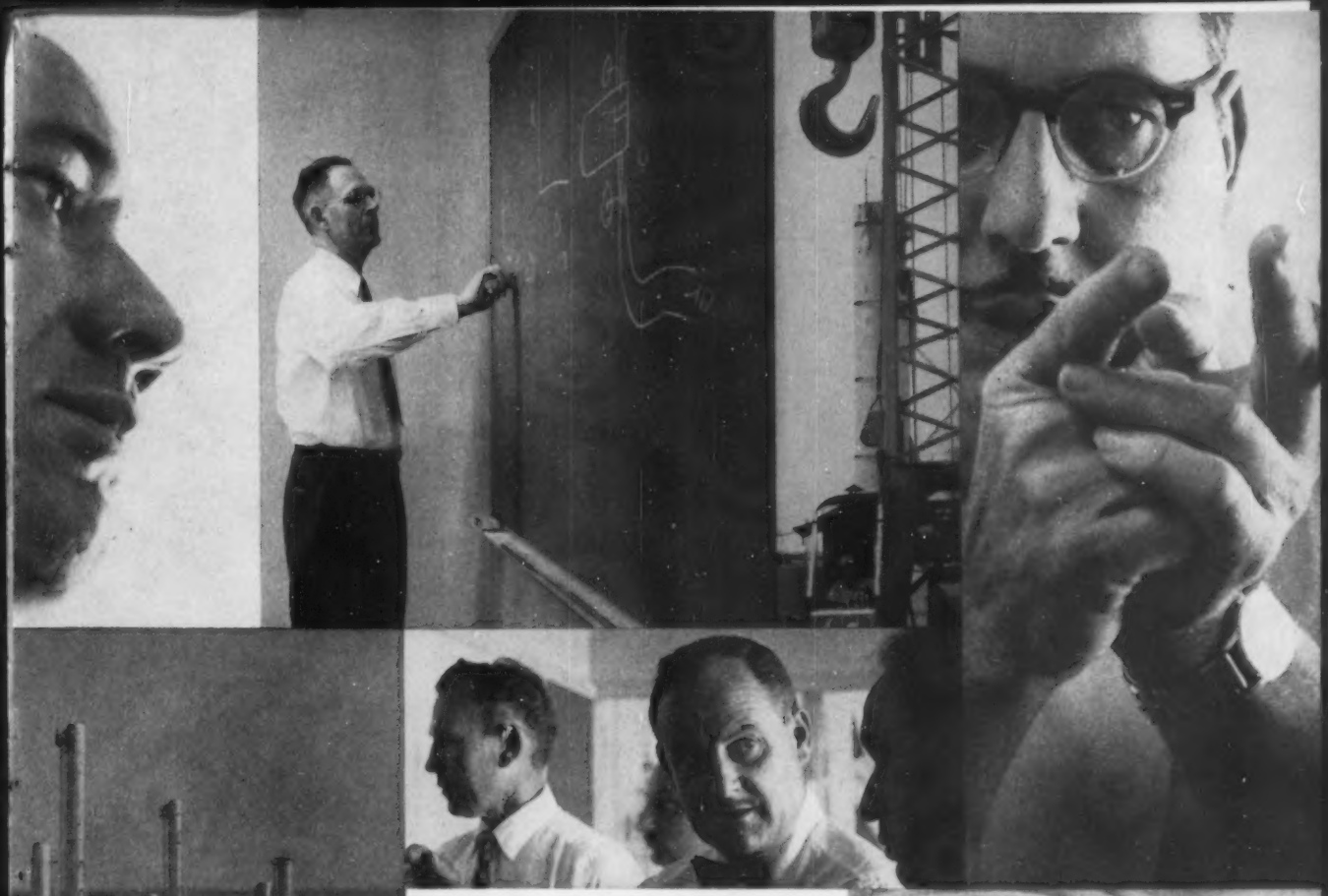
Universal Oil Products Co. designed, engineered and licensed the unit.

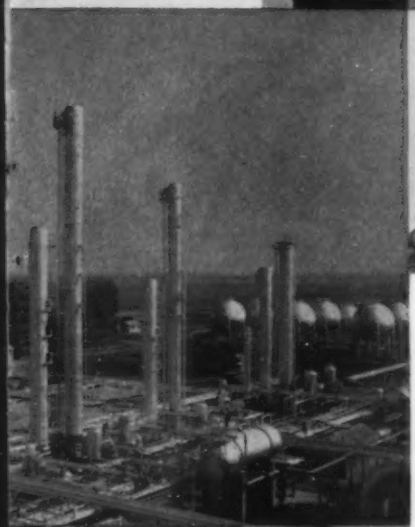
Esso, A. G., reports that construction of one of the largest oil refineries in West Germany is nearing the half-way mark. The refinery is being built at Cologne to increase the supply of petroleum products in the Rhine Valley.

The project is being supervised by a seven-man crew from Esso Research and Engineering Co., Linden, N. J. The plant will be able to process 68,500 bpd of crude oil. West Germany had a refining capacity of about 350,000 bpd at the end of 1957.

The fuels section of the plant is about 42 percent completed and should be finished by the end of this year. It will produce high-octane gasoline, heating and diesel oils and other middle distillates. The chemicals section, which will make

For more data on advertised products, use Readers' Service Cards, last page.

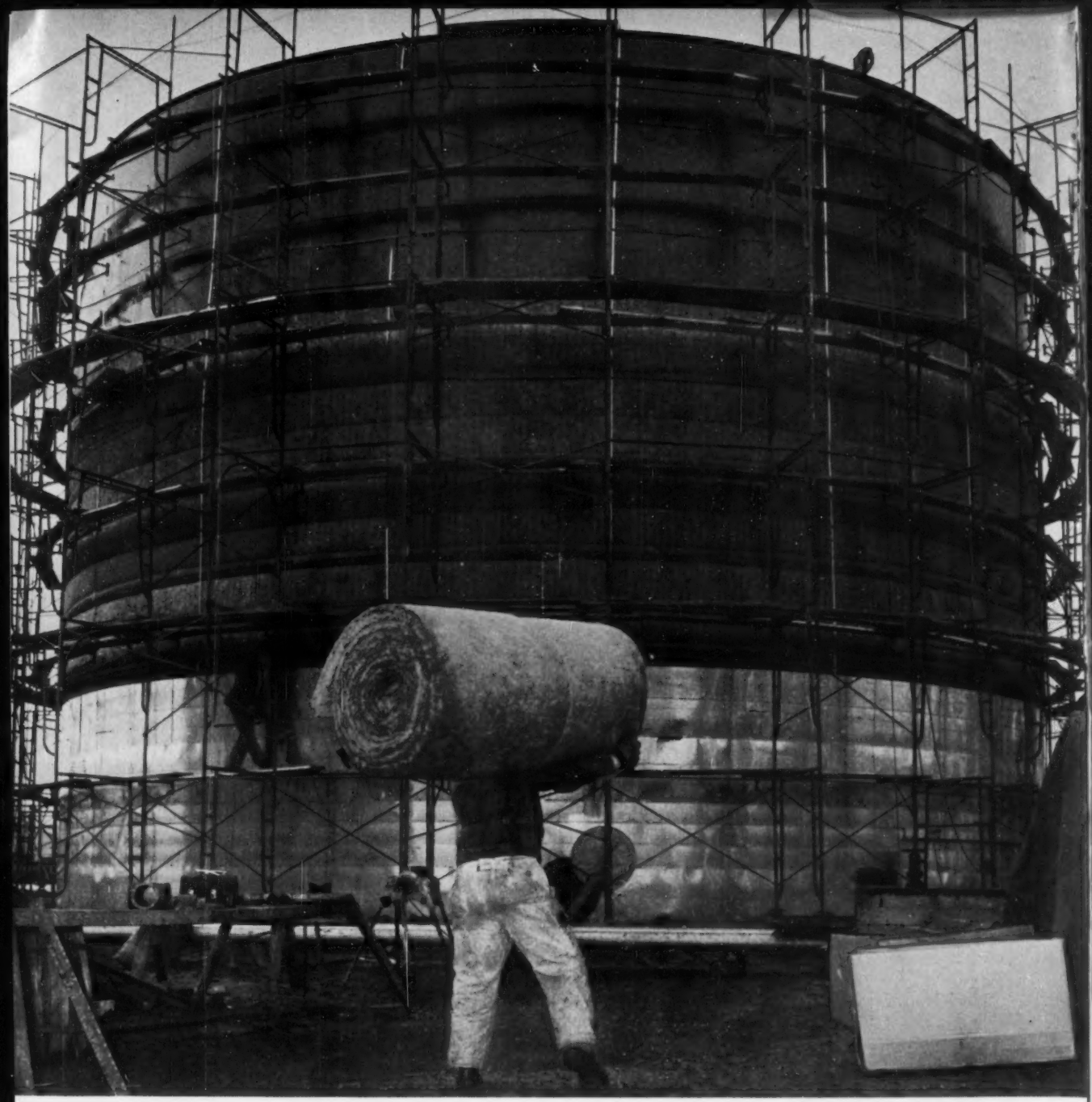




WHEN you consider expansion...
...the most important
investment you can make is in
the creative ability of men.

FLUOR

The Fluor Corporation, Ltd.
Engineers & Constructors
2500 S. Atlantic Blvd., Los Angeles



He's carrying enough ULTRALITE to insulate 600 sq. ft. of tank!

. . . and in short order, that 600 sq. ft. roll of ULTRALITE glass fiber insulation will be permanently in place on the tank. Resilient ULTRALITE simply *wraps around* tanks, vats and vessels . . . takes only a fraction of the time required by the bat-at-a-time method. ULTRALITE "hugs" tanks closely, eliminating cracks and fluing action, and its K factor is only .27 at 70° mean temperature.

It all adds up to this: with ULTRALITE you can do a "deluxe" job—including metal weatherproofing sheets—*at no extra cost!* For details, write direct or—

CALL YOUR G-B INSULATION DISTRIBUTOR (LISTED IN ADJOINING COLUMN)

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

242 W. 10th St., Kansas City, Mo.

G-B ULTRALITE DISTRIBUTORS

(See ad on facing page)

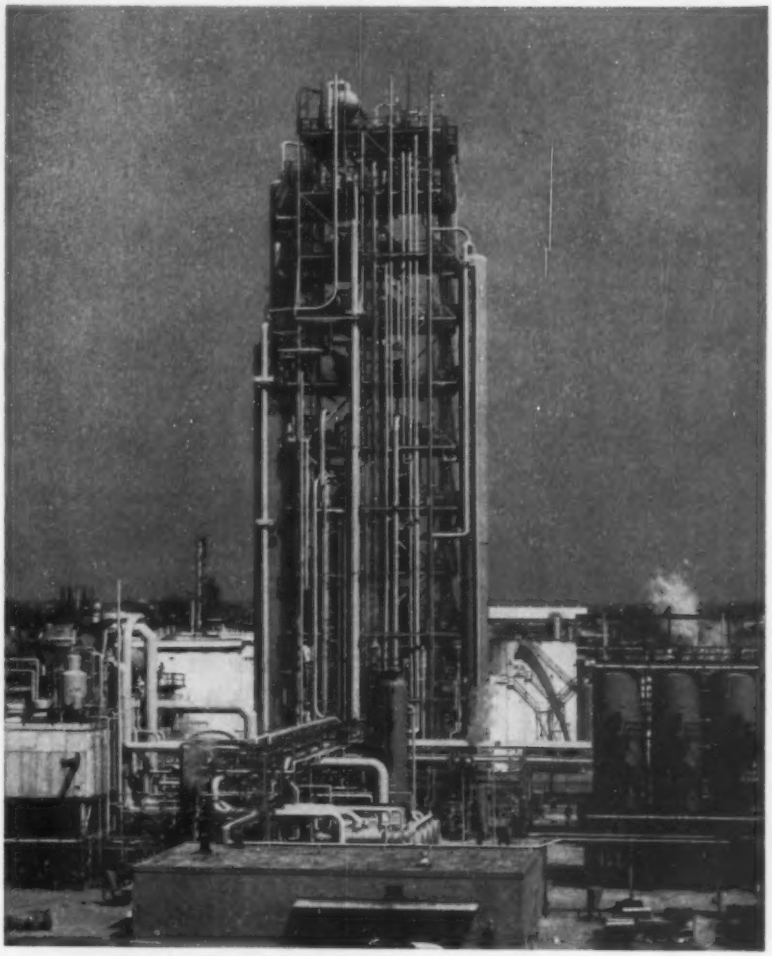
ALBUQUERQUE, Mt. States Insulation Co.
AMARILLO, Ball Distributing & Engr. Co.
ATLANTA, Ga., Reynolds Aluminum Supply Co.
BALTIMORE, Md., Leroy Insulation Co.
BILLINGS, Mont., Big Horn Supply, Inc.
BIRMINGHAM, Ala., Shook & Fletcher Supply
Reynolds Aluminum Supply Co.
BOSTON, Mass., Homans-Kohler, Inc.
BROOKLINE, Mass., Homans-Kohler, Inc.
BUFFALO, Industrial Insulation Sales, Inc.
CHARLESTON, W. Va., Baldwin Asbestos Products Co.
CHARLESTON HEIGHTS, S. C., Stafford Insulation Co.
CHARLOTTE, N. C., Guy M. Beaty & Co.
CHATTANOOGA, Guy M. Beaty & Co.
CHICAGO, E. C. Carlson Co.
CINCINNATI, R. E. Kramig & Co.
CLEVELAND, The Miles Materials Co.
COLUMBUS, Santeler Brothers
CORPUS CHRISTI, Texas, Precision Insulation Co.
DALLAS, Insulation Supply Co.
Payne-Ladewig, Inc.
DAVENPORT, Republic Electric Co.
DENVER, Gene Wright Lumber Co.
DES MOINES, Iowa Asbestos Co.
DETROIT, Coon DeVisser Co.
EL PASO, Insulation & Specialties Co.
EVANSVILLE, Ind., George Koch Sons, Inc.
FARGO, N. D., Smith, Inc.
FT. SMITH, Ark., Gunn Distributing Co.
FT. WAYNE, Ind., M. H. Hilt, Inc.
FT. WORTH, The Bracken Co.
GREENSBORO, N. C., Starr Davis Co., Inc.
GULFPORT, Miss., Paine Supply Co.
HOUSTON, Precision Insulation Co.
INDIANAPOLIS, Central Supply Co.
IRON MOUNTAIN, Mich., Champion, Inc.
JACKSONVILLE, Ferber Sheet Metal Works
JACKSON, Miss., Paine Refrigeration & Supply Co.
JOPLIN, Mo., Joplin Cement Co.
KANSAS CITY, Kelley Asbestos Co.
LITTLE ROCK, Gunn Distributing Co.
LOS ANGELES, Western Fibrous Glass Products
Thorpe Insulation Co.
LOUISVILLE, General Insulation & Roofing Co.
MEMPHIS, John A. Denie's Sons Co.
MIAMI, Crabtree Insulation Co.
Reynolds Aluminum Supply Co.
MILWAUKEE, F. R. Dengel Co.
MINNEAPOLIS, Asbestos Products, Inc.
MOBILE, Ala., Shook & Fletcher, Inc.
NASHVILLE, Reynolds Aluminum Supply Co.
NEWARK, N. J., Eastern Steam Specialty Co.
NEW HAVEN, Conn., Insulation Supply Co.
NEW ORLEANS, Eagle Asbestos & Packing
NEW YORK, Eastern Steam Specialty Co.
OKLAHOMA CITY, Ball Distributing & Engineering Co.
OMAHA, Cardinal Supply & Mfg. Co.
PHILADELPHIA, John F. Scanlan, Inc.
PITTSBURGH, Dravo Corp.
PHOENIX, Ariz., Kircher Asbestos & Rubber Co.
RALEIGH, N. C., Reynolds Aluminum Supply Co.
RAPID CITY, S. D., Robbins & Stearns Wholesale
RICHMOND, Va., Reynolds Aluminum Supply Co.
ROCKFORD, Ill., Mott Brothers Co.
SALT LAKE CITY, Bullough Asbestos Supply Co.
SAN ANTONIO, The Bracken Co.
SAN DIEGO, Western Fibrous Glass Products
SAN FRANCISCO, Western Fibrous Glass Products
SAVANNAH, Ga., Reynolds Aluminum Supply Co.
SEATTLE, Western Fibrous Glass Products
ST. LOUIS, The Stovey Company, Inc.
ST. PAUL, Asbestos Products, Inc.
SYRACUSE, N. Y., Industrial Supply Co.
SULLIVAN, Ill., Lewi David, Inc.
TAMPA, Fla., Eagle Roofing & Art Metal Works, Inc.
TALLAHASSEE, Fla., Bakers, Inc.
TULSA, Okla., Ball Distributing & Engr. Co.
TUPELO, Miss., Paine Supply Co.
WASHINGTON, D. C., Walter E. Campbell Co., Inc.
WICHITA, General Metals, Inc.
VANCOUVER, B. C., Fleck Brothers Limited

GUSTIN gb BACON

butadiene and ethylene, will not be finished until next June.

Esso, A. G., also has a refinery in Hamburg.

Who's Building . . .



Esso Gets New Ethylene-Purification Unit

A new ethylene-purification unit has been placed in service at Esso Standard Oil Co.'s refinery in Baton Rouge, La. It makes the Baton Rouge plant one of the nation's major producers of high-purity ethylene, according to H. J. Voorhies, the Baton Rouge Refinery's general manager and a vice president of Esso Standard. Most of the output will go to industries in the Baton Rouge area for use in making a variety of petrochemical products. The unit uses a distillation process to produce high-purity ethylene from a mixture of refinery gases. Construction plans were announced two years ago. To assure continuity of supply, one of five salt-dome cavities—or "wells"—in the refinery's underground-storage facilities at Sorrento, 35 miles south of Baton Rouge, is used for ethylene storage. It has a capacity of 300,000 barrels. The product is moved between the refinery and Sorrento by pipe line.

Dow Badische Chemical Co. has been given a Delaware charter, with authorized capital of $6 million. Dow officials stated that Dow & Basfoberzee, N. V., overseas subsidiary, Badische Anilin & Soda Fabrik, A. G., have formed the new subsidiary with a view to looking into production of acetylene chemicals.

Each parent company has a 50 percent interest in Dow Bodische, and present plans are for construction of a new plant in Texas.

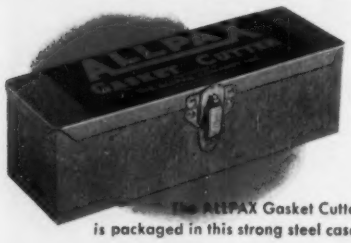
Industrias Plasticas Argentinas Koppers, S. A., a partially-owned subsidiary of Koppers Company, Inc., has signed a contract with Yacimiento Petrolifero Fiscales (YPF), state-owned oil company of Argentine, which may result in construction of ethylene and polyethylene plants at La Plata, a town just south of Buenos Aires.

The agreement depends on several factors, including licensing and other approvals by the Argentine government and

For more data on advertised products, use Readers' Service Cards, last page.

Cut Perfect Gaskets *Easily* with the ALLPAX Gasket Cutter

If you can draw circles with a compass you can cut perfect gaskets in seconds with this handy kit. Just set the blade for the desired thickness, set the pivot post at the desired diameter, and a smooth swing of the cutter gives you a clean, accurate gasket . . . from a ¼ inch bolt hole to a 60 inch outside cut. Larger diameters can be cut with additional extension arms.

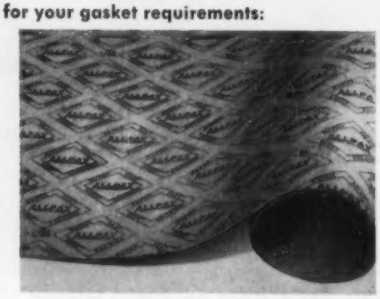


The ALLPAX Gasket Cutter is packaged in this strong steel case.

The ALLPAX Gasket Cutter has become standard equipment in thousands of plants where expensive "down time" is kept at a minimum by cutting new gaskets when and where they are needed. Available in five styles to cut maximum diameters of 12, 24, 36, 48, 60 inches.

Use the following Allpax gasket materials for your gasket requirements:

400—Compressed Asbestos Sheet
500—Superheat Compressed Asbestos Sheet
600—Vegetable Fiber Oil Proof Sheet
700—Red Rubber Sheet
750—Black Rubber Sheet
800—Diaphragm Sheet
850—Cloth-Inserted Sheet



ALLPAX

"The Packing that Packs All"

SEND FOR OUR NEW CATALOG — TODAY!

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 8, Quebec

Who's Building . . .

the raising of capital, a large part of which is expected to be furnished from within Argentina.

The plants would use gas from the YPF refineries nearby to make ethylene, which would be made into polyethylene. Koppers would furnish the engineering and operational management.

The Texas Co. will add three new units to produce high-octane gasoline blending stock at its Lawrenceville, Ill., refinery. Construction is scheduled to begin in November on a feed preparation unit with a rated capacity of 26,000 bpd, a hydrotreater and a catalytic reformer, each with a 12,000 bpd capacity.

The catalytic reformer will be the second of its kind to be installed at the refinery and will double the production capacity for reformate, an important component of high-octane gasoline.

The construction and engineering contracts have been awarded to the Bechtel Corp., and the units are scheduled for completion late in 1959.

Steelman Gas Ltd., is building a gas plant, gathering system, and transmission line in southern Saskatchewan. The big project will cost in the neighborhood of $16 million. Gathering system and flare gas conservation plant will cost some $11 million. The Saskatchewan Power Corp.'s southern transmission line to the gas plant will require an expenditure approaching $5 million.

The plant, processing 25 million cubic feet of gas daily and ultimately a possible 60 million cubic feet, is expected to be operating in the fall or winter of this year. The plant will be located in the Steelman oil field in south-eastern Saskatchewan.

Standard Oil Co. (N. J.) is one of seven oil companies planning to build "as soon as possible" a 2,000,000 ton-a-year refinery near Algiers to handle Sahara crude oil.

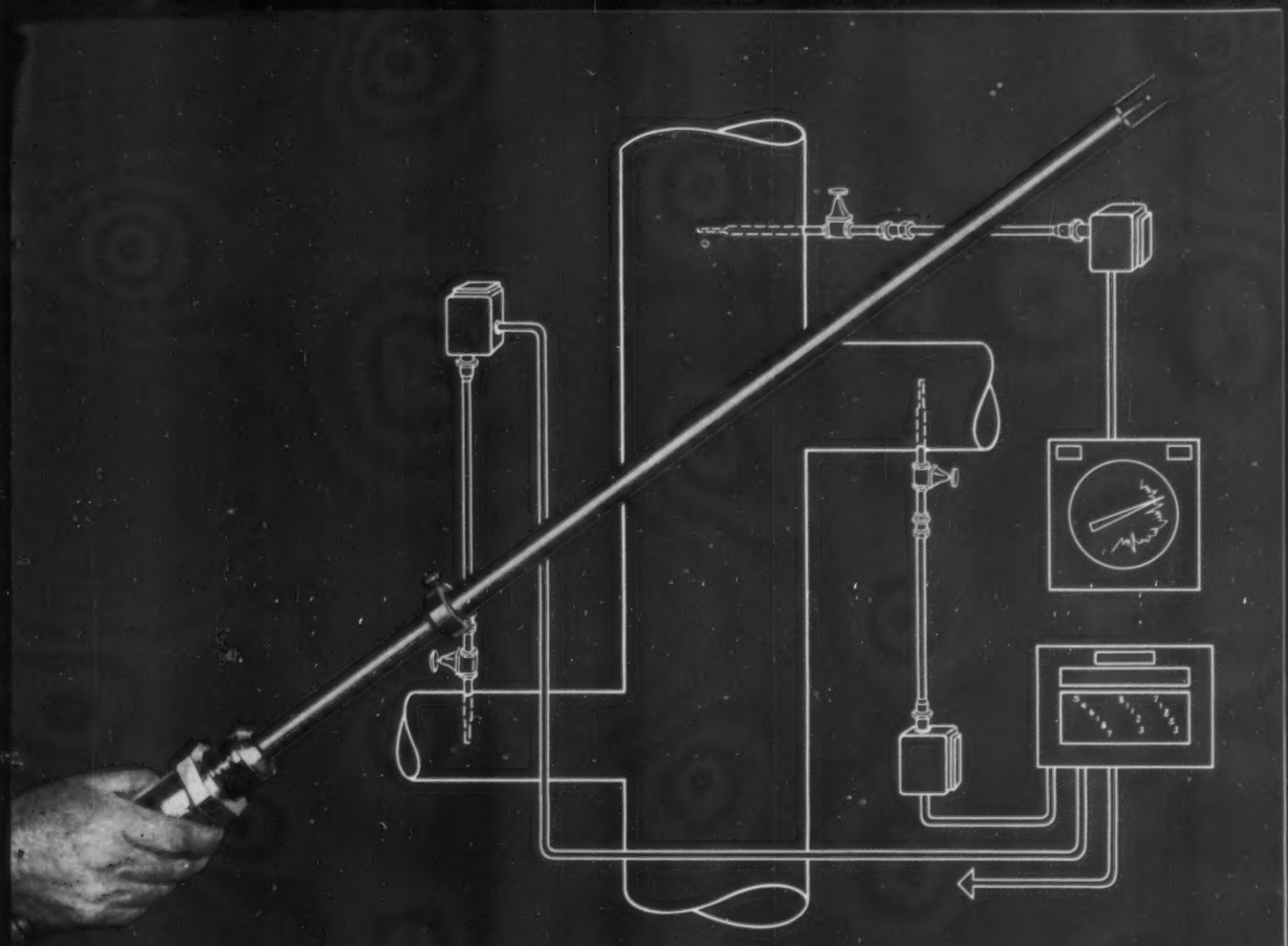
A new company is being formed—Societ de la Raffinerie de'Alger—to handle building operations. Other founder members are Beryl Algerie, Compagnie Francaise Des Petroles, Compagnie Francaise de Raf Vfinage, Mobile Oil Francaise, Societe Francaise Des Petroles B. P. and Societe Shell d'Algerie.

American Chemical Corp., a subsidiary of Richfield Oil Corp. and Stauffer Chemical Co., is planning construction of a plant for the production of chlorinated hydrocarbons. Present plans call for a Southern California location. C F Braun and Co., is conducting preliminary design studies.

Petroleos Mexicanos is building 55,000 bpd primary distillation plant at Ciudad Madero, Tampico. It is also studying what may be discovery of a new oilfield in Tepalcatepec, Michoacan state, after reports that a farmer digging water well on his land had struck oil at depth of 35 ft.

Ftalital S. p. A., an Italian firm, will build a 2.2 million-pound-per-year maleic anhydride plant at Scanzorosciate (Bergamo), Italy. It will be the first to be built in that country.

Scientific Design Co., and an affiliated company, Societe Francaise des Services



Probe for profits with the

New "ANEMOTHERM"

Probe-Type GAS FLOW METER

- **Stainless Steel for durability**
- **Electronic for accuracy**

Refineries report savings of thousands of dollars per day in reduced flaring losses with the new "Anemotherm" Gas Flow Meter. That's because this probe-type electronic instrument *accurately measures* gas flow through the *complete range* of velocities.

The new "Anemotherm" Gas Flow Meter also provides these important benefits:

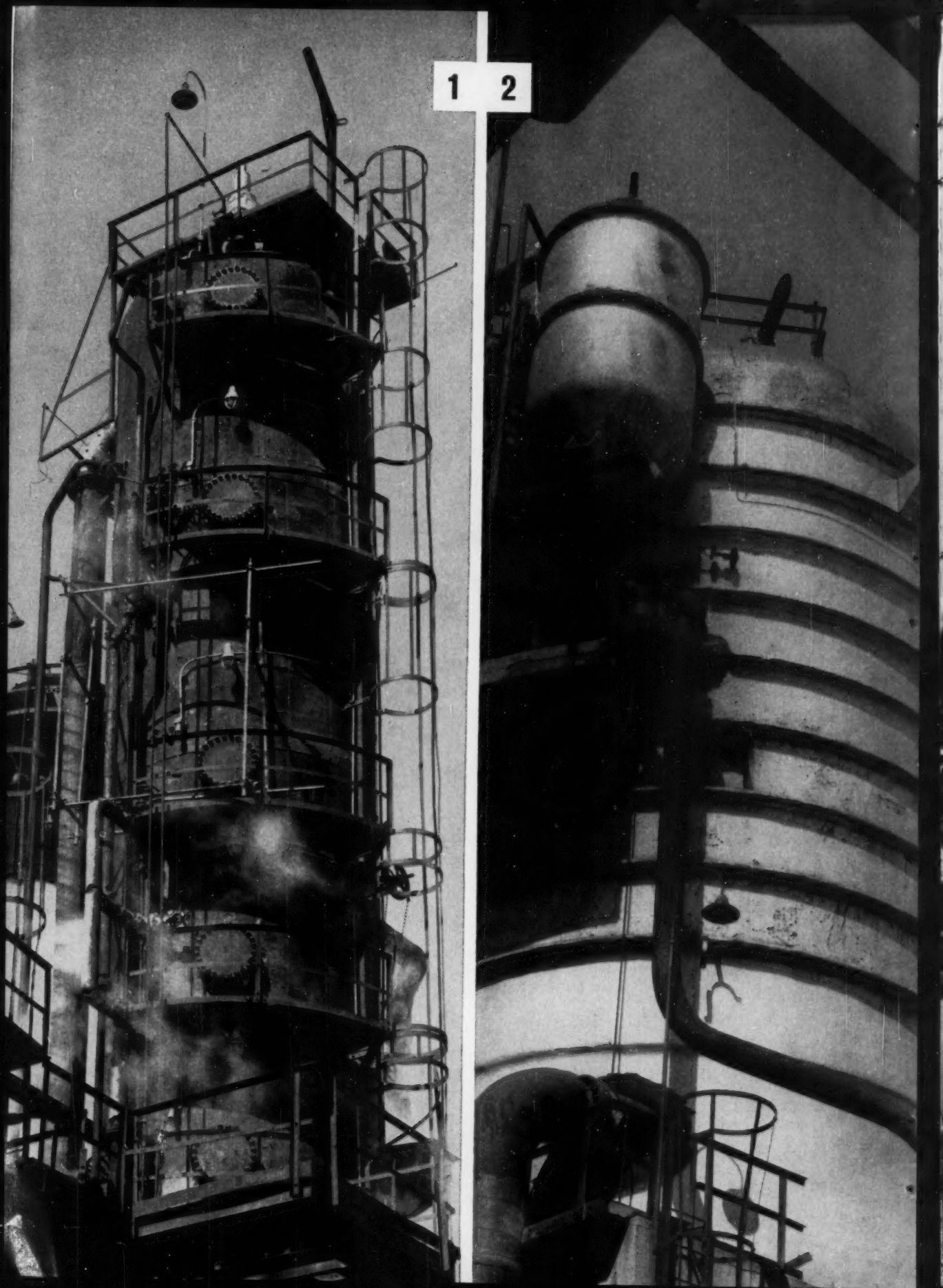
- Practically no resistance to flow
- Reads velocity from 5 feet per minute to 2,500 feet per minute
- Accuracy ± 5% of meter reading
- Corrosive resistant stainless steel
- Can be used with standard recorders reading from 1 to 16 points
- Controls any type of equipment whenever velocity sensing can be the control influence
- Can be used in practically any gas
- Withstands temperatures up to 300 F
- Easy to install
- Easy to clean

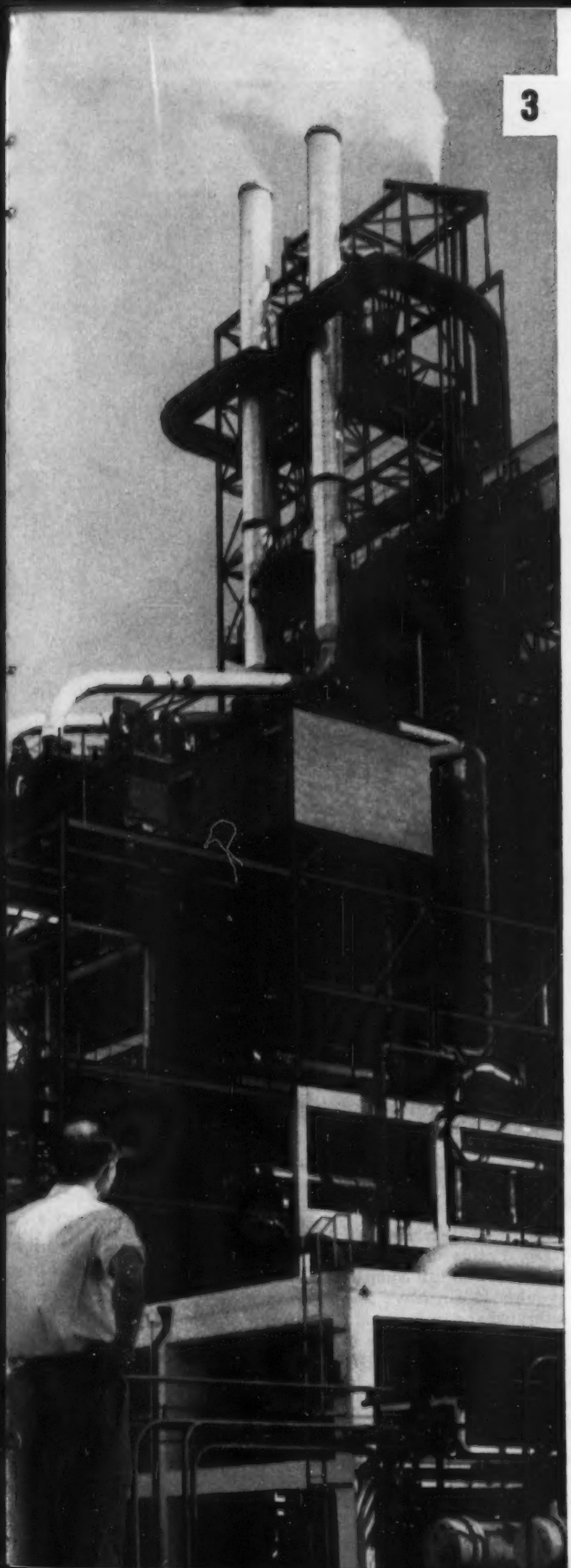
Look into the money-saving accuracy and efficiency of the "Anemotherm" Gas Flow Meter. Send for 12-page Technical Bulletin 5000 giving complete engineering data.

ANEMOSTAT®

ANEMOSTAT CORPORATION OF AMERICA
10 East 39th Street, New York 16, N. Y.
Representatives in Principal Cities

AC1366


1
2



3 Stainless Steel wins three more battles with corrosion

1 High temperature sulfur corrosion from sour crude destroyed every metal tower in this plant. As the failures occurred, all towers were replaced with Stainless Steel lined equipment. Not one lining has failed since, and some of them have been in service continuously for eight years.

2 Two vacuum evaporators at this plant remove gas oils and asphalt from reduced crude at operating temperatures of 740° F. The evaporators were unlined at first, and inspection showed that they were failing rapidly from high temperature sulfur corrosion, coupled with severe erosion caused by the crude which entered the evaporators under pressure. The evaporators were promptly lined with Stainless Steel sheets, and, in five years of service, the sheets showed practically no wear. Plant engineers say they will be good for five to ten more years.

3 When they switched from sweet crude to sour crude in this "cat" cracker, the lower section of the fractionating tower corroded and had to be shut down for major repairs. The tower was repaired by installing Stainless Steel in all corroded areas. After three years of operation, the Stainless Steel was still in excellent condition.

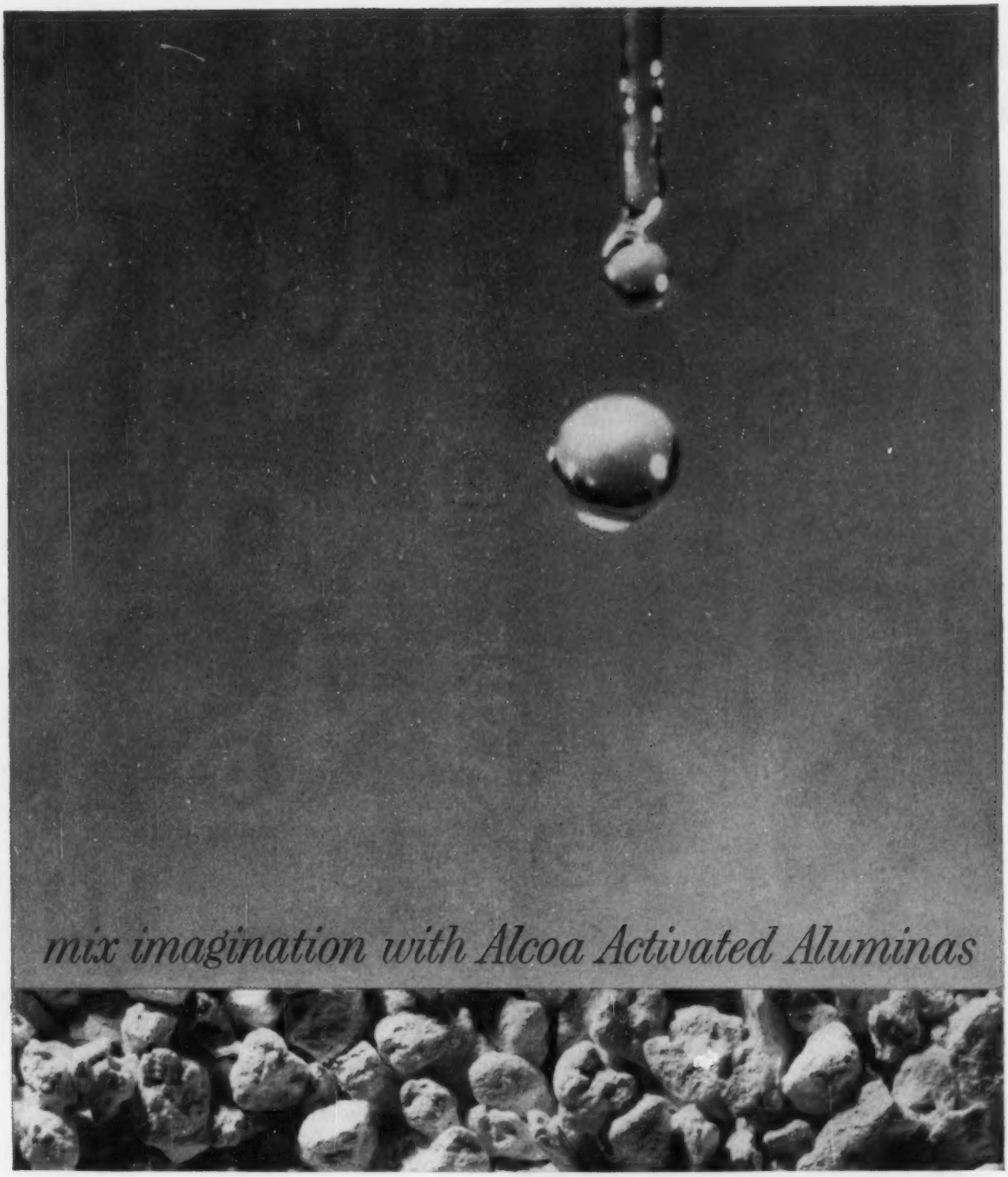
When you consider all the materials that go into a refinery or petrochemical plant, very few will show such dramatic results as Stainless Steel. No other metal has such a desirable combination of corrosion resistance, surface density and smoothness, strength (even at high temperatures) and ease of fabrication. Build and repair with Stainless Steel. And for service-tested quality, specify USS Stainless Steel.

USS is a registered trademark

USS

United States Steel Corporation – Pittsburgh
American Steel & Wire – Cleveland
National Tube – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
United States Steel Export Company

United States Steel



to remove the last drop of unwanted product or process water. Is unwanted water undermining your product quality . . . or ruining the efficiency of your process? If so, try this sure solution to your dehydration problems: mix imagination and engineering with Alcoa® Activated Alumina. You can count on this old reliable among commercial desiccants to achieve the lowest dew points you require. It can never soften, swell or disintegrate. It is nontoxic, noncorrosive and practically iron-free. It can be saturated and reactivated through almost endless cycles—to keep drying costs low. Put the proved effectiveness of Alcoa Activated Alumina to work in solving *your* dehydration problems. Drying machines charged with Alcoa Activated Aluminas are available from a number of manufacturers. For their names, or for product information, contact your local Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-J Alcoa Building, Pittsburgh 19, Pa.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

For finer products . . . let Alcoa add new dimension to your creative thinking!

Who's Building...

Techniques S.a.r.l., Paris, will furnish the process engineering and major equipment design for the new plant, plus technical liaison.

Ftalital, according to a company spokesman, is a leading European manufacturer of phthalic anhydride, with a capacity of 37.4 million pounds per year.

Nippon Petroleum Refining Co., Ltd., is on stream with Japan's second combination Unifining-Platforming unit at Yokohoma. It has a design capacity of 3,300 bpsd. Processing naphtha from Middle East crudes, the unit is a pretreater for the Platforming operation.

Universal Oil Products Co. designed and engineered the combination unit and licensed it through Japan Gasoline Co., Ltd. Japan Gasoline Co. did the detailed design and construction.

Canadian Oil Co., Ltd.'s Sarnia refinery processed 5,146,000 barrels of crude oil during the first half of the year, which is at the rate of 28,000 barrels per calendar day. The refinery's expansion from 30,000 to 50,000 bpd is now underway, with completion scheduled for the fall of 1959.

When the refinery was opened in 1952 its rated capacity was 20,000 bpd.

Shell Chemical Corp. has awarded contracts for the construction of remaining facilities in its glycerine production program at the Norco, La. plant. Cost of this phase of the program was estimated at more than $10 million. Construction will be completed late next year.

One unit will produce acrolein. A second will make glycerine, using acrolein and hydrogen peroxide from a unit that the company completed earlier this year.

Other construction includes extensions to the utilities system and other off-site facilities, and additions to shops, warehouses and the office building.

The Norco plant will make about 35 million pounds of glycerine a year plus substantial quantities of acrolein.

Glycerine production at Shell's Houston plant will be decreased as the Norco unit comes on stream, according to the company. Feed stock for the Houston unit, mostly allyl chloride, will be shifted into the production of other products such as epoxy adhesives and plastics.

Engineering contracts for the acrolein unit were awarded to The Lummus Co., New York; for the glycerine unit to Ralph M. Parsons Co., Los Angeles; and for the off-site facilities to The Fluor Corp., Los Angeles.

Contracts for additions to the shops, warehouses, office building and the change house for employees will be given to building contractors in the Norco area. These expansions have been designed by August Perez and Associates, New Orleans architects.

Esso Standard Oil Co. is planning a full-scale replacement program for its Bayonne refinery's chemical products plant.

Most of the facilities in the 27-year-old plant will be replaced by new equipment when the program is completed at the end of 1959. Rebuilding will be handled on a step-by-step basis, as the plant will continue operations while construction is going on.

Slated to be erected in the replacement

DO YOU HAVE A LIQUID DRYING PROBLEM?

You can now attain water levels below 10 ppm and sometimes below 1 ppm by using Molecular Sieve driers. This degree of dryness would be difficult or impossible with paper presses, distillation towers or chemical desiccants.

Molecular Sieve drying systems are available in any size with either single or multiple beds. Operation can be continuous or intermittant and variation of flow rates or composition of the stream does not affect product purity. Even at low inlet water levels, Molecular Sieve systems maintain a high water capacity. *And,* important in so many areas, Molecular Sieves have high water capacity even at elevated temperatures.

Many plants are now taking advantage of this highly efficient method of drying liquid systems. Here are some examples of liquids which are now being dried commercially with LINDE Molecular Sieves—

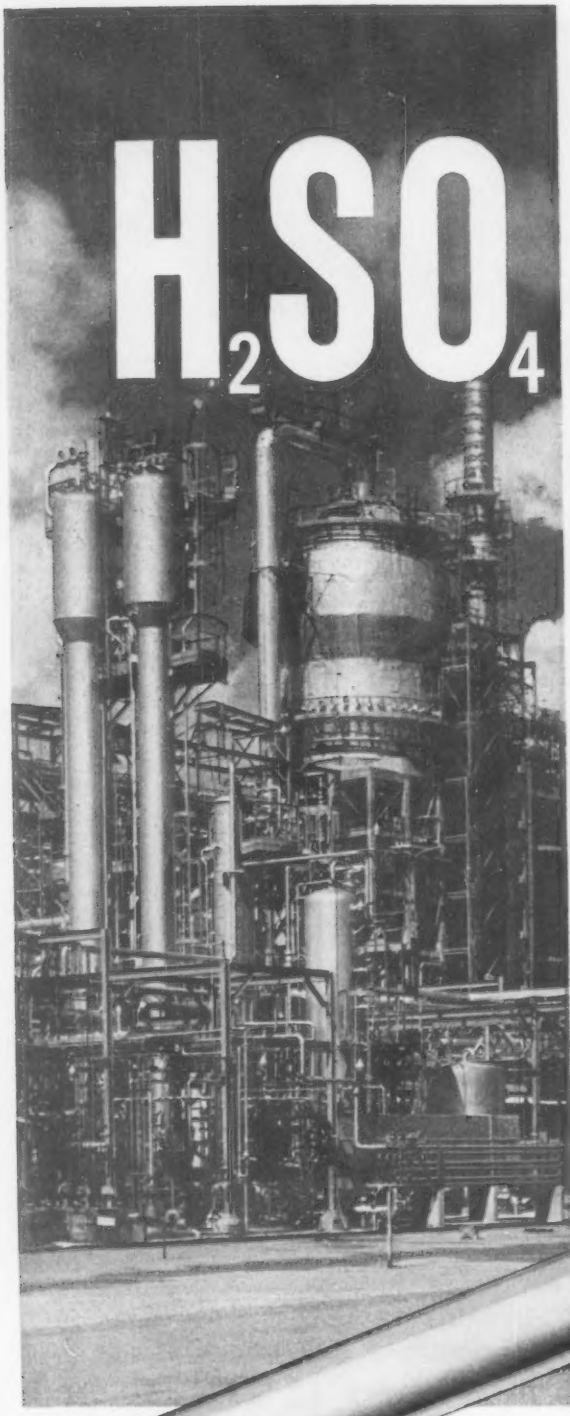
Acrylonitrile	n-Hexane
Benzene	Phenol
Butane	Propylene Dichloride
Ethylene Dichloride	Propylene
Flourocarbon Refrigerants	Pyridine
Hydrocarbon	Solvent
Mixed Xylenes	Solvent Mixture
n-Heptane	Transformer Oil

Molecular Sieves have also been tested in many others systems—systems as difficult to dry as water-alcohol azeotropes, ketones, ethers, and so on. Performance data are available on request.

If you are looking for a way to dry a liquid stream—or if you need to improve the performance of an existing drying system—let us show you how Molecular Sieves can work for you. When you order your Molecular Sieve Drier, we will work closely with the equipment manufacturer of your choice. Write, wire or phone today, Molecular Sieves Dept., Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Telephone YU 6-6200, Ext. 365.

"Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

For more data on advertised products, use Readers' Service Cards, last page.



in any concentration...

at any temperature to 500°F

can't corrode Fluoroflex®-T piping

liner of Teflon® in thermal equilibrium with housing

Sulfuric, hydrochloric, nitric, hydrofluoric–*any* acid is harmless to Fluoroflex-T piping.

Universally inert liner. Steel pipe and fittings are lined with Fluoroflex-T... a patented, high density, *non-porous* compound of Teflon.

Liner and housing are in thermal equilibrium through an exclusive process developed by Resistoflex. It compensates for thermal expansion differential between the Teflon and the pipe housing, eliminating fatigue collapse, and cracking at the flange.

Solves problems, saves downtime, saves money. Type S piping installed in steam cooking process for recovering sulfuric acid from coal tar sludge at 250°F and 50 psi has been in service over a year with no maintenance difficulties.

See how Fluoroflex-T Type S piping systems can end problems of corrosion, erosion and contamination for you. Send for detailed Bulletin TS-1A. Dept. 130, RESISTOFLEX CORPORATION, Roseland, New Jersey. Other Plants: Burbank, Calif., Dallas, Tex.

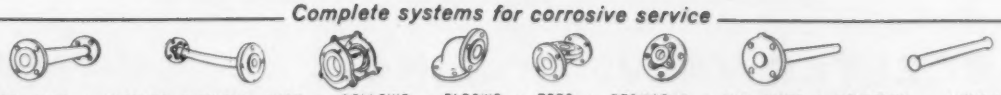
® Fluoroflex is a Resistoflex trademark, reg., U. S. pat. off.
® Teflon is DuPont's trademark for TFE fluorocarbon resins

Specially engineered resistant products for industry

For more data on advertised products, use Readers' Service Cards, last page.

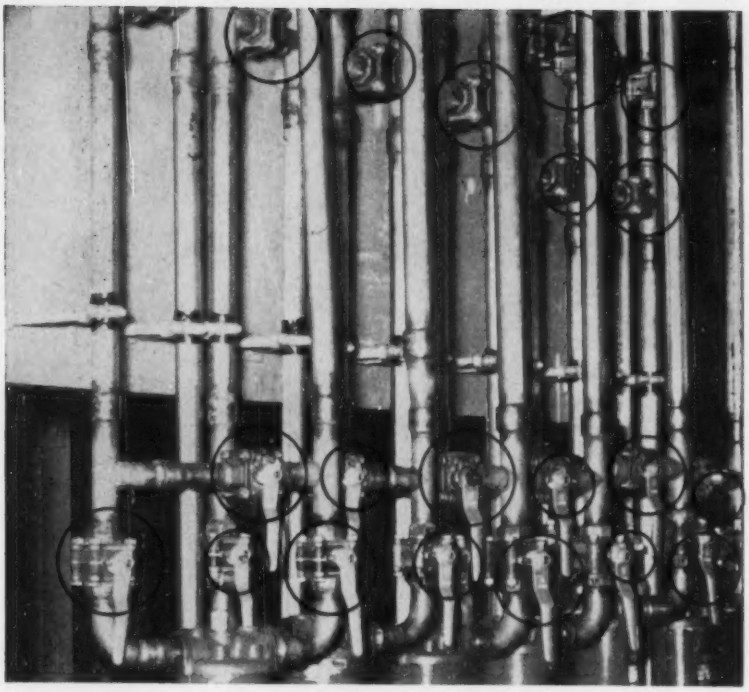
RESISTOFLEX

Complete systems for corrosive service



LINED STEEL PIPE • FLANGED FLEXIBLE HOSE • BELLOWS • ELBOWS • TEES • REDUCERS • DIP PIPES & SPARGERS • LAMINATED PIPE

For more data on advertised products, use Readers' Service Cards, last page.



Only the ECON-O-"MISER" Ball Valve was able to solve this problem for PathéColor, Inc.

THE PROBLEM: To find a valve that would meet all of the following requirements:

1. Quick visual indication of position and quarter turn operation. 2. Excellent flow characteristics and positive shut-off. 3. The advantages of flange construction without the bulk and weight of conventional flanged valves. 4. Easy & quick disassembling for low cost maintenance. 5. The most compact and economical installation of Type 316 stainless steel valves possible.

SOLUTION: *Specifying* and *installing* Worcester's Econ-o-"miser" Ball Valve. In so doing PathéColor found a valve that provides a positive seal, a flanged construction much more compact than conventional valves that could be socket welded. In addition many unions and companion flanges were eliminated with the overall result that savings on this installation alone amounted to many hundreds of dollars.

Valves available, ¼"-2", in following standard materials*: Bronze, Aluminum Bronze, Aluminum, Carbon Steel and Types 303 and 316 Stainless Steel. Standard Seat and O-Ring materials*: Buna-N, Neoprene, and Teflon.

**Other materials available on request.*

For further information and descriptive literature write to:

WORCESTER VALVE CO., INC.

16 PARKER STREET • WORCESTER, MASS.

Who's Building...

program are a new reactor building, a new alcohol receiving unit, new tanks, pumps and pipe-ways, and a new tank-car loading rack. Automatic drum loading facilities will be installed in the storage building which was completed last year.

Preliminary site clearing has begun, and full scale construction slated to get under way in the fall. No expansion of manufacturing is planned as part of the replacement program. The project is designed to bring facilities up to date—there has been no major rebuilding of equipment since the unit was started in 1931.

The new plant, however, will be more flexible than existing facilities. One of the first structures to go up under the program will be a transite-covered reactor building. To stand 60 feet long by 40 feet wide, it will house three reactors and accessory pumps and filters along with supervisors' offices, a lunch room and sanitary facilities. Construction is slated to start in November with completion scheduled for May of next year. Two new 4,000-gallon reactors will be installed in the new building and one existing reactor will be relocated.

Altogether, 34 new tanks, ranging in capacity from 2,500 to 100,000 gallons, will be erected. Six 14,000-gallon tanks will be relocated from the area where new lube oil facilities are under construction.

The new tanks will replace the 46 existing tanks of various sizes which will be dismantled on a gradual basis.

While some present equipment is to be relocated, most existing facilities will be dismantled. Semi-automatic drum fillers are to be installed in the existing storage building. They will replace the manually-operated filling equipment now in use.

Esso Standard Oil Co. will invest some 2 billion pesos in enlarging its Chilean plant at Maipu & Las Salinas and in its contribution to Sociedad Nacional de Oleoductos, which is to build and work an oil pipeline between Concon and Santiago.

Esso-Raffineriet A/S, Norwegian subsidiary of Standard Oil Co., New Jersey, will commence construction of a refinery in the near future. The refinery will be situated at Slagen, near Tonsberg, on the western side of the Oslo Fjord. The refinery will have a capacity of 40,000 bpd.

X-L Refineries, Ltd., is building an asphalt plant at Dawson Creek, British Columbia. The 350-bpd plant will produce asphalt for road paving in the surrounding area.

Olin Mathieson Chemical Corp. is building a 500-ton-per-day sulfuric acid plant, which will increase production by 250 percent at its Beaumont plant. The company is also constructing a new facility for the production of ammonium sulfate.

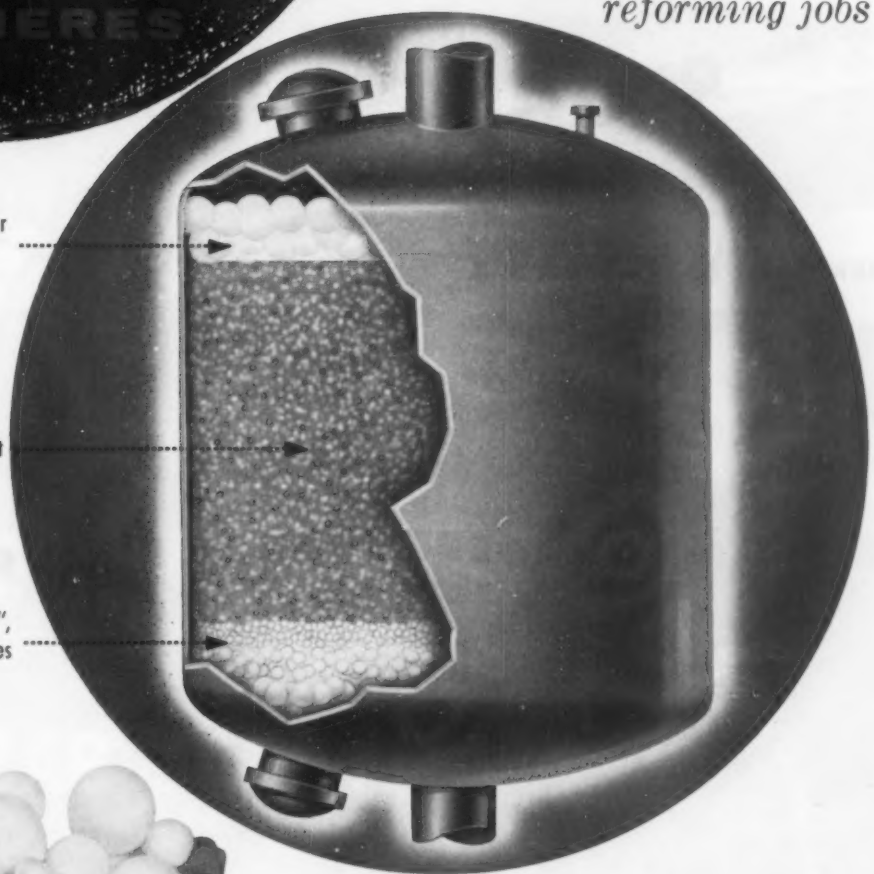
Humble Oil & Refining Co. is planning to build a polypropylene plant at Baytown. Expected to be in operation late in 1959, it is being designed with an initial capacity of 40 million pounds a year which can be expanded up to 100 million pounds a year.

Petromina, a Venezuelan firm, was reported to have contracted to build a refinery at Villa Hayes, Paraguay. Petromina's contract was also subject to elaborate financing arrangements.

For more data on advertised products, use Readers' Service Cards, last page.

PATTERSON ARLCITE SPHERES

. . . tough customers for your toughest catalytic reforming jobs



- Chemically Inert
- Zero Absorption
- Stability at High Temperatures
- High Resistance to Shock
- Smooth Surface

Inert, rugged, commercially proven—ARLCITE 86-8 Spheres when used as catalyst bed support and hold-down material thrive in operating conditions such as these—pressures of 550 to 750 psi.—temperatures to 2000°F. with instantaneous temperature changes of 200 to 250°F.

After two years service in one Gulf Coast refinery, Arlcite Spheres have shown no signs of failure or breakage, contributing to operating economy and peak production.

Arlcite 86-8 Spheres, a high alumina ceramic material, is scientifically bonded to assure the ultimate in mechanical strength, resistance to crushing, erosion and abrasion. Complete chemical inertness and smooth surface give freedom from contamination of highly sensitive and valuable catalysts.

Write for complete details.

FERRO

THE *Patterson* FOUNDRY AND MACHINE COMPANY
East Liverpool, Ohio

THE *Patterson* FOUNDRY AND MACHINE CO. (CANADA) LTD.
Toronto, Ontario

A Subsidiary of Ferro Corporation

For more data on advertised products, use Readers' Service Cards, last page.

WARREN QUALITY
WARREN QUANTITY
WARREN SERVICE
Braided Together...
to give you
DEPENDABLE DELIVERIES
of
NATURAL GASOLINE
WHATEVER THE GRADE, WHATEVER THE VOLUME
WHEN, WHERE and the WAY
you want it!
WARREN
PETROLEUM CORPORATION
TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN
EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN,
TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

The Fine Art of Growing Larger

Expansion by acquisition and merger is a broad road to industrial glory—but it should be used only by the strong who are blessed with plenty of fortitude

Ernest Hart, President
Food Machinery and Chemical Corporation, San Jose, Calif.

AN ACQUISITION or merger in many respects is like a chemical reaction where you are attempting to make a new compound out of two elements. You know pretty well what the reaction of one of the elements (your business) will be and you *think* you know how the other element is likely to react. However, you put the two together in a single test tube and often you come up with a strange and unlooked for new compound which may not be exactly what you anticipated. Other times, and less frequently, you may come up with a wonderful new compound in which case it will usually resemble gold.

This merely points out that in the case of acquisitions or mergers the more you really know about the elements that go into it the more likely you are to get a compound that resembles gold; and remember cheap elements rarely result in a valuable compound.

Also remember that management is always a key characteristic of any such elements. There are a lot of others, to mention a few: traditional practices in production, sales, research, etc. on both sides. Salary, retirement, vacation policy, stock option policy, location of plants, anti-trust conditions, reputation, consumers' satisfaction, legal situation and hundreds of others also on both sides.

A Matter of Emphasis. First off—there is no fine line between expansion by acquisition and other methods of expansion. Actually, most successful enterprises, including Food Machinery and Chemical Corporation, have used several methods simultaneously, and will no doubt continue to do so. It is simply a difference between two philosophies; one puts the emphasis on growth by acquisition, the other puts the emphasis on other methods of development and growth.

There must always be a sound and impelling reason for wanting to acquire a business. Among the most important of these are the following:

1. Expansion of product lines in the same business. There are literally hundreds of examples of this type of acquisition which will come readily to your mind.

2. Expansion of product lines in related industry. Here you will think of an oil or rubber company entering the chemical field.

3. Expansion into new fields. Typical examples here are Food Machinery entering the chemical business; Cyanamid entering the pharmaceutical business.

4. To secure improved markets for your products, i.e., acquiring your customers. I am sure you can think of many such examples.

5. To secure tested management and other personnel. Watch this one carefully as I think general experience will indicate a very low batting average in the long run.

6. To up-grade basic manufactured products. An example here would be up-grading chlorine to chlorinated products.

7. To acquire a needed or an attractive patent position or to expand a patent position in a given field.

8. To come into possesion of basic raw materials, such as mines. An illustration of this is in our acquisition of the Westvaco Chemical interests which controlled major deposits of raw material such as, phosphate rock, trona ore, salt, etc. which had not been fully exploited by the acquired

company or in most cases not exploited at all.

9. To accomplish diversification of manufactured products. An example of this would be American Machine and Foundry Company now operating in many diversified fields of manufactured products.

10. To accomplish the quick establishment of skilled research, both facilities and personnel, in the direction of desired growth. This, of course, is an alternative to slow and long term development to accomplish the same purpose.

11. To establish a desired relationship between the production of capital and consumable goods. Our company is a good example of this. Ten or 12 years ago we were exclusively in the business of producing capital goods—machinery. We decided it would be good business to invest part of our capital in a consumable goods industry. So we entered the chemical field—by acquisition. We chose the chemical industry, and the early acquisitions were made in that field, because of the close relationships which exist between the chemical companies acquired and the food industry—an industry which at that time was largely served by FMC in the mechanical field. An additional advantage thus gained was to diversify profits as well as production and sales so as to cushion shocks of recession, which seldom occur in both capital and consumable goods at the same time. In other words, to bridge lean times from the profit angle.

12. To up-grade gross profit percentage by acquiring high-profit specialty lines.

13. To obtain sales distribution or to reduce distribution expense by coverage of the same customers with additional product lines.

14. To obtain geographic advantages in sales, freight, new markets and many others.

15. To acquire needed process facility and operational skills quickly and ready-made.

16. To acquire trade marks or trade names or the advantage of established customer acceptance.

17. In some cases, there are certain tax advantages to be gained by well selected acquisitions or mergers.

18. Finally, there is just the plain every-day ambition and urge to grow fast.

All of the foregoing, represent sound and compelling reasons for development by acquisition. You may wish to add to this list.

The Search Starts. We now come to the point where the acquirer, having in mind a definite objective or objectives, begins the search for a company which is in a position to be acquired, and which fulfills the desired specifications.

The acquirer is aided and abetted in this search by a large group of those who make a profit, directly or indirectly, from such a combination. You know banks, brokerage houses, management council concerns, freelance agents, your own Development department and many other organizations and individuals are constantly turning up prospects for acquisition. However, few such prospects meet all of the requirements, and usually compromises result.

So far this is a very beautiful story, and I believe you will all agree that the quick acquisition of all or many of the advantages I have mentioned makes a highly desirable system of growth and expansion. In fact, it is the high road to industrial glory when compared to many of the slower methods of integrated development from within. But this isn't the whole picture. There are pitfalls—some very deep. Experience and skill in avoiding these pitfalls, or rapidly getting out of them when caught, is the essence of successful expansion by acquisition or merger.

From the Other Side. I have spelled out some of the reasons which motivate the acquirer. I now need to remind you of a few of the reasons that activate the acquiree. These usually fall into the following general categories:

1. Lack of capital for development and growth.

2. Lack of research facility which can be furnished by the buyer.

3. Lack of market facility which can be furnished by the buyer.

4. Overage of management, individual or group, creating desire for retirement; poor health of management; and estate considerations, either tax-wise or management-wise, which make essential the liquidation of fixed assets into either cash or securities with a ready market.

5. Unexpected death of key personnel with no trained replacements. This happens particularly in a small successful company, the product of one man genius who has made no plans whatsoever for "D" day but suddenly realizes that it is later than he thinks.

6. Fear of competition, either in old product lines or in new developed products which will replace old lines on the market.

7. Failure or bankruptcy — avoid this one!

One Example. Consider now the situation where a company having a sound reason for an acquisition comes into common focus with a company having equally sound reasons for being acquired.

Negotiations are undertaken to determine in what manner the acquisition shall be made—perhaps by cash, perhaps by exchange of stock or similar methods. It could be done by merger, by the absorption of the company into an existing operation, or by operation as a semi-autonomous division or as a subsidiary.

It must be determined what portion of the acquiree organization is to be retained and in what manner. Also what the operational financial plans shall be, which acquirer's policies can be quickly integrated, what are the problems with respect to possible confusion or duplication in marketing, production, purchasing, advertising and dozens of other every day problems which sooner or later must be successfully resolved between the two parties.

The Deal Is Set. At last the deal is completed and everybody is happy. Glasses click, the lawyers go home, there are pictures and press releases, the stock market reflects the good points in the program—and the honeymoon begins!

Like most honeymoons it is usually a short one. Then comes the real test of the soundness of the acquisition. The covers are gradually kicked off, and the "bride" and the "groom" become exposed to the chill winds of reality. At this point, absorptive ability and diplomatic skills determine the extent of the success of the larger enterprise. Perhaps I can best illustrate what I have been pointing out to you by giving you a brief, anonymous and typical case history. Names are deleted to protect the innocent.

The Cat and Mouse. A large, successful and financially sound corporation "A" has negotiated an ac-

quisition with a small successful organization "B," as a result of which "B" becomes a division of "A." On the appointed dates public announcements are made and "A" takes over. Everybody in "A" is happy. "A" is the cat which has swallowed the mouse. There is no apprehension throughout the "A" organization; in fact, there is much pleasant anticipation.

In "B" organization the situation is the opposite. There is little anticipation; the feeling is deep apprehension. Nobody in "B" has been consulted regarding the maneuver, and therefore insecurity replaces security pell-mell. Rumors and grapevine information begin to filter down through the organization regarding jobs, policies, moving to other geographic points, what are the new monsters like, and what-not. This for a period of times creates operational vacuum in "B".

These uncertainties are not confined to "B"; they promptly spread to the customers of "B", and the purchasing agents and others wonder at once what is going to happen to their established position with "B". In fact, they may not even like "A" for some reason and they promptly envision the distasteful "A" policies being promptly adopted by "B".

This situation is further complicated by the fact that the sales manager of "A" and his cohorts in the field promptly see an advantage which can be gained against other competition by perhaps throwing "B" into the ash can or absorbing his best people, and getting rid of at least one competitor for whom he has been gunning for years. This same sales manager also sees an opportunity to combine lines and reduce his selling expense, which has always been a controversial point with his management.

Internal Headaches. Next, when "A" goes into "B" affairs in detail he finds incongruous situations which are entirely out of line with policies of "A" and which, if continued in "B", will seriously affect the morale and long established operational policies. "A" finds, for example, that his development department manager, who handles twice the work and has twice the staff of "B", receives only two-thirds the income that "B's" development manager receives—do I need to go further with this point?

Next, "A" finds himself confronted with inconsistent trade practices concerning distribution, terms, etc., which if continued will seriously jeopardize his own position with the trade and with his competitors. He also finds on his hands a large and perhaps partially obsolete inventory which must be liquidated. Then too, he is confronted with a series of accounts and trouble cases which do not fit at all with his concept of how business should be conducted. He also finds that for the past ten years "B" has pursued the practice of giving a cash or merchandise bonus at Christmas, a practice "A" has studiously avoided. Discontinuance of the practice would seriously affect the morale of "B"; its continuance would seriously affect the morale of "A."

Then comes the question of finance. "A" finds immediately that new money must be made available to implement waiting and necessary plans for capital expenditures, increased production of inventory, new accounts receivable and items of a similar nature. These cash requirements are immediate and may even exceed the amount of the purchase price, a problem which calls immediately for a substantial amount of venture capital.

He finds also that because "B" was expecting to liquidate, or be acquired, that its recent attention to good will has lacked something, that its market information is out of date, its machinery and equipment are obsolete, its research and development department staff has not been "on its toes" in recent years, and most of the better personnel have been acquired by competitors.

"B" Fights Back. The Research and Development department of "A" wants to absorb the similar department of "B" and "B", of course, musters argument, some good, against absorption. Cooperation at first is nil, and suspicions of motives on both sides lead to misunderstanding, friction and a lack of progress.

The production manager of "A" is assigned the job of supervising and indoctrinating "B" into the production policies, cost accounting and other practices of "A." "B" submits, reluctantly, but privately believes the production manager of "A" is an old "fuddy-duddy" with outmoded ideas and no sound knowledge of production, cost accounting or anything else. A general battle ensues, the casualties and outcome of which are not known for some little time.

The purchasing department of "A" promptly bounces into the ring. It sees a change to add purchasing power and prestige by acquiring the volume of purchases formerly made by "B". So "A" angles for the control of this function in various and devious ways. But "B," meanwhile, supported by its old-time vendors, yields slowly, if at all, and many intricate situations evolve.

I could go on and on, but I am sure that by now you fully understand the type of basic organizational and personnel problems with which both sides of this acquisition are immediately faced.

Another problem is presented in financing, which is now assumed by "A", as are tax and major accounting matters. As a result, most of "B's" staff hitherto engaged in this work is no longer required. This situation necessitates a major and sometimes serious operation.

Oh yes! I almost forgot about the competitors. They slide quietly into the picture, seeing an opportunity for a possible advantage. Their field men and others (not being fully informed) become responsible for ugly rumors which create uncertainty among customers and prospective buyers. Competitors, you know, are a restless lot and the damage here is sometimes severe.

Finally Harmony. In spite of all of these handicaps the indoctrination and absorption of "A's" policies by "B" begins, and little by little the obstacles mentioned are overcome and new blood of the "A" type is pumped into "B". It is even possible that some of the "B" type blood becomes transfused into "A" and with the absorption and coordination of the best talent in both "A" and "B" the acquisition begins to click and the advantages of such acquisition to come to the surface and grow.

With plenty of cash, plenty of tact, plenty of patience, plenty of understanding the fruit begins to ripen and while still subject to the attack of worms and disease, a harvest is begun and the Board of Directors of "A" in meeting assembled (after about five years) congratulate themselves upon the fact that they had the wisdom and foresight to authorize the acquisition.

A Quick Summary. Expansion by acquisition and merger to be success-

News and Notes on...

Good Packing Practice

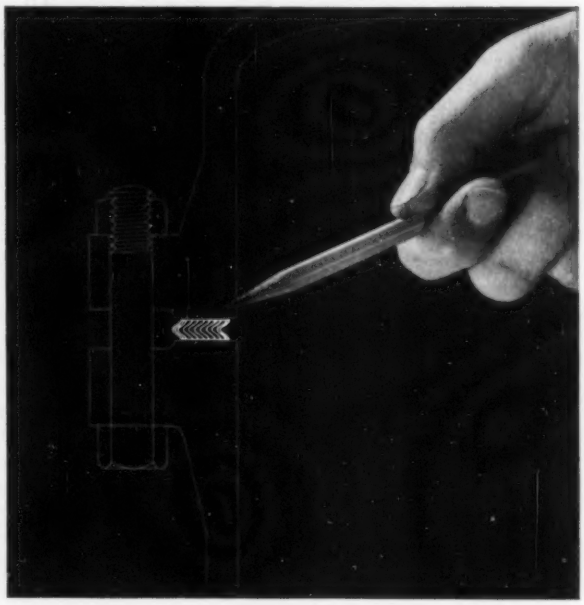
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: Selecting the Gasket

Question:

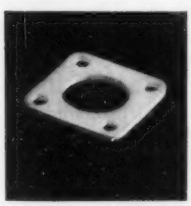
What are the important points to remember about gasket applications so we can avoid costly failure?



GASKET engineering is a complex study, but there are certain simple answers to this commonly asked question. Briefly, at least three variables must be considered. These are: 1. The available bolt force on the gasket. 2. Internal pressure and temperature. 3. The nature of the contained fluid.

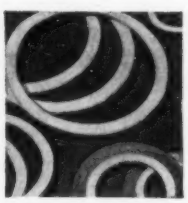
Starting with bolt force: it must be adequate to flow the gasket material and cause it to yield and seat effectively. Secondly: the bolt force must also always be sufficient to exceed the internal pressure and temperature forces that work against gasket closures. Finally: the gasket material must be impervious to the action of the confined fluid.

For service at low to medium temperatures and pressures: As a rule of thumb, if multiplying the operating pressure (psi) by operating temperature (°F) results in a product not exceeding 250,000, a quality "general service" type gasket can be used with complete safety. An outstanding gasket material for these operating conditions is J-M Service® Sheet #60 . . . a tough, durable compressed asbestos sheet. Service Sheet seals effectively against hot or cold water, steam, oils, mild acids and caustics.



If corrosive fluids are encountered: The best solution to the constant attack of chemicals and solvents is a gasketing material that is chemically inert. For this kind of service condition, Johns-Manville Teflon* Chempac® Gaskets are recommended. They are available in pure Teflon, low-flow (glass-filled) Teflon, Teflon-Asbestos, and in metal-Teflon combinations.

*TM for DuPont Tetrafluorethylene resin.



When extreme pressures and temperatures act on the gasket: If internal pressures reach 1200 psi or temperatures exceed 850°F, safe practice calls for a sturdy gasket that offers the high resiliency needed to follow expanding and contracting movements of flanges. For standard flange applications to 6,000 psi, you will find metal-asbestos, spiral-wound Goetze Spirotallic® gaskets most efficient. They offer high mechanical strength and resilience. Their special interlocking design and stainless steel construction is especially designed to effect and maintain a tight seal despite wide pressure and temperature variations.

To solve any sealing problems, call your J-M Packings and Gaskets field representative. He's equipped to give you information on new products . . . engineering and design advice. For information on any J-M Packings or Gaskets write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

ful must have a definite objective—probably one or more of those I have listed for you. Also, acquisitions should only be made with a full knowledge of the inevitable pitfalls and disadvantages. Finally, experience dictates that growth by acquisition and merger requires experience and skill. It is then only a supplement to internal development.

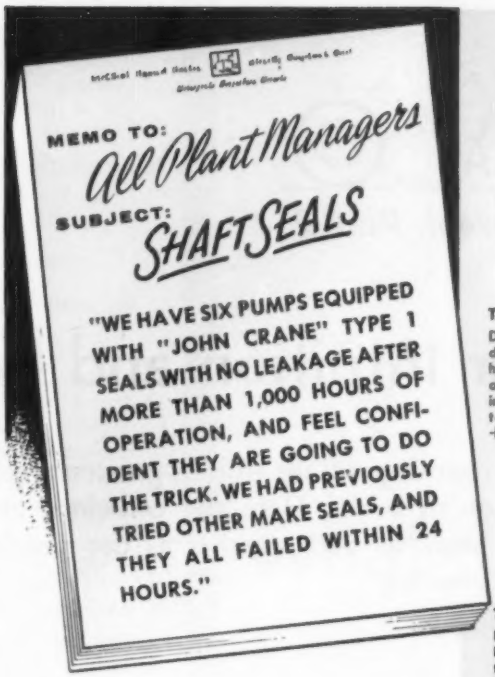
There is no denying the quick rewards to be realized by successful acquisition and merger when practiced by those with money, know-how, a strong absorptive ability and plenty of patience and tact. It is the high road to quick industrial glory but it is a rocky one, unpaved and unposted and suitable for use only by the strong who are blessed with plenty of fortitude.

Originally presented before the Chemical Market Research Association, May 21, 1958, in New York.

About the Author

Ernest Hart, president of Food Machinery and Chemical Corp., is well qualified to write on expansion by acquisition and merger. During his business experience he has been on both sides of the fence—first, by seeing his company acquired by another, and second, by being a party to later acquisitions and development programs which followed. Therefore, his knowledge is first-hand.

Hart received his M.S. degree in horticulture and his Ph.D. degree in agriculture, both from Michigan State University. He started his career with Niagara Sprayer and Chemical Co., which was acquired by Food Machinery and Chemical in 1943. In 1947 he was made president of Niagara Chemical division and vice president of Food Machinery and Chemical. In 1953 he was made executive vice president and became president in 1956. Hart is past president of the National Agricultural Chemical Association, and the Manufacturing Chemists Association. He is also a director and chairman of the Executive committee, Petrotex Chemical Co., Houston.


MEMO TO:
All Plant Managers
SUBJECT:
SHAFT SEALS
"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

This is part of an actual memo sent by one plant manager to others of the same company in different sections of the country—and that company is now exclusively specifying these and other type "John Crane" Shaft Seals for *all* their liquid handling requirements.

You too can save time, trouble and expense by doing likewise.

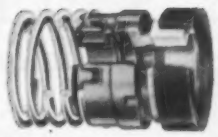
You'll find a "John Crane" Shaft Seal for every service . . . from hot or cold water to the most destructive acids and corrosives . . . high temperatures, high pressures . . . in types and sizes to meet practically any mechanical or dimensional requirement.

Send us details on your application. We'll recommend the proper shaft seal. Request Bulletin S-204-3 for complete overall information.

Crane Packing Co., 6420 Oakton St., Morton Grove, Illinois, (Chicago Suburb).

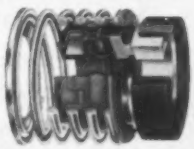
In Canada: Crane Packing Company, Ltd., Hamilton, Ont.

John Crane®



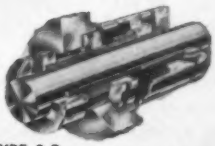
TYPE 1

Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids non-injurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



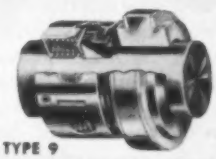
TYPE 2

Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.



TYPE 8-B

Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.



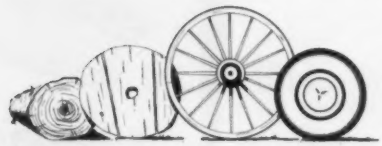
TYPE 9

Famous as a problem solver. Sealing members of chemically inert Du Pont Teflon. Engineered to service conditions to handle practically all destructive acids, corrosives and gases at temperatures from −120°F. to +500°F., pressures to 150 psi. Available in balanced construction for pressures to 750 psi.

John Crane

CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.



How to Invent: Part 2

Use Your Intuition and Imagination

You have at your disposal the world's greatest workshop—the human brain. Here the conscious and subconscious work as well together as the muscles and bone of your leg

Forrest E. Gilmore
Independence, Kansas

AMONG THE COMMON mental blocks to invention is the feeling that ones does not have the laboratory or other facilities with which to discover and try out new things. Usually this lack is not as great a handicap is it may appear to the potential inventor. After all, the human brain with its 100 billion or so nerve cells is the greatest laboratory in creation. However, the brain does not come stocked with supplies of knowledge nor relationships of material things. You must obtain all of these by conscious effort, closely observing and comparing, studying, thinking and remembering.

Your attitude must be that nothing is perfect and therefore you can either improve anything under consideration or devise something better. You must study everything you can to know all about it and how it works, what its shortcomings are, etc., and continually try to conceive something to improve it.

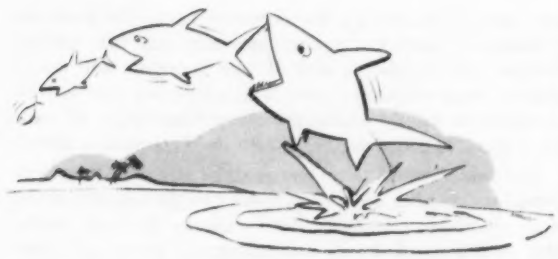
Your Subconscious Mind. As knowledge about anything accumulates, interest in it increases. And back in the deep laboratory of the mind, called the unconscious or the subconscious by psychologists, brilliant work is done to solve the problem of the conscious mind. Frequently, however, the solution offered by the subconscious is unsatisfactory, so the conscious mind calls for more study, observation and meditation. All the outside laboratory can do is furnish this study and observation to obtain knowledge. Then, this knowledge is used by the real laboratory, the mind.

Imagination alone is the door to and from this mind laboratory, but it is impossible to imagine anything except in terms of what we have seen, heard, felt, tasted or otherwise sensed. To become a successful inventor, therefore, you must continually expand your imagination by carefully feeding it through sharp observation and experiences in many fields—even if obtainable only by reading and study. Then exercise your imagination in the most natural way—by deliberate practice.

Many men of outstanding ability and extensive experience invent by using their imagination to visualize the application of consciously thought-up ideas, and their experience to determine the probable results. Undoubtedly you can invent by this method if you are willing to put forth the effort to acquire the knowledge and experience necessary for this deliberate thinking.

Idea Chain Reaction. There is no limit to creation or to creative ideas. By association of similarity, ideas beget ideas, ad infinitum. So to be creative, it is advisable to listen to other people's ideas with great interest and try

Nothing is perfect so you must be ready to improve or devise something better . . .



By association of similarity, ideas beget ideas, ad infinitum . . .

to expand upon them. You should do this even though some of these ideas seem neither logical nor reasonable. You should also, throw your ideas out on the table at the appropriate moment. They may inspire new ideas from others which in turn may cause you to have some better new ones.

Remember, however, you cannot have good ideas of how to improve the game of baseball for instance, without first knowing a lot about baseball, a lot about other games and a great deal about people. If you know only one field of endeavor you are not apt to invent or really excel in it. You need to know many fields well and a few exceptionally well.

The Role of Intuition. Intuition springs from the subconscious. In using the subconscious part of the mind, I do not wish to imply a physical separation of the conscious and subconscious, but rather a way of functioning as though they were separate. Some controversy has existed over which is more important in creative thinking, the conscious or the subconscious. It is rather like comparing the muscle with the bone of the leg; both are needed to progress.

With the mind as a whole, both the conscious and the subconscious are needed for intelligence, memory, thought and understanding. I have found in myself, and most inventors and other creative thinkers have found in themselves, that the unconscious or subconscious contributes greatly to creativity. Therefore, from the psychological viewpoint much of which follows may be quite unorthodox. However, it is not written to teach psychology but to help potential inventors with a technique which works.

The Mystery of Thought. How the mind functions has always been mostly a mystery. It has been written about by many authors, particularly those of a philosophical or psychological bent. Many believe we shall never know, for the Creator never intended us to know just how matter can think. Regardless of our limitations, it is an extremely interesting subject for any thinking person to investigate, especially those interested in speculative thoughts. The various theories advanced do not lend themselves to any substantial degree of proof, so you can find ideas to support almost any position you may take on the subject.

Regardless of whether or not it is true that you actually have a subconscious mind, as a rule, you can get better creative thinking results by using a technique based on the assumption that your brain works as though it has

what does

$$\triangle F/A = \triangle p$$

mean to you?

(Continued on next page)

(Advertisement)

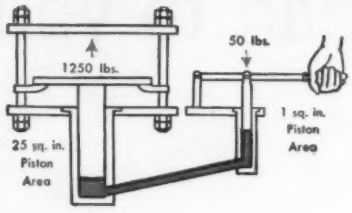
(Continued from preceding page)

$$\triangle F/A = \triangle p$$

. . . is the mathematical expression for Pascal's Principle which states that: "pressure applied to a confined fluid is transmitted uniformly to all areas of the confining fluid."

In the drawing below, notice how a relatively small pressure of 50 pounds applied to the 1 sq. in. piston raised 1,250 pounds on the 25 sq. in. cylinder. Pascal discovered how to multiply the muscles of man a thousand fold! Today, the light touch of a woman's toe against a foot pedal smoothly yet quickly slows and halts a two ton automobile.

Pascal's Principle had been known for hundreds of years when a man by the name of Sven Nordstrom successfully applied the principle to



Here is a demonstration of Pascal's Law. A given pressure of 50 lb lifts 1250 lb over an enlarged area of 50 to 1 ratio

create a most unusual innovation in valves—his invention, the lubricated plug valve. In the most elementary terms, this valve is simply an old fashioned plug cock (used since the days of Pompeii) to which Nordstrom ingeniously applied the Principles of Pascal.

(advertisement)

two parts. First, there is the objective part—the part that is conscious, knows it is conscious and can will, reason, observe and decide, as well as pass thoughts and sensations to your subjective part. The subjective part is your unconscious mind, where somehow knowledge of your every sensation, experience, thought and emotion is stored.

The subconscious mind seems to be not only the storeroom for thoughts, somewhat similar to the memory drum of an electronic computer, but to also be the great workshop of the mind. In it, everything we know and have experienced through the senses as well as by conscious thought, is available as raw material for our use in manufacturing ideas which are communicated to the conscious mind through imagination. Imagination creates the conceptions of the subconscious in the conscious in terms of our senses, that is, visual, auditory, tactual, olfactory, savory or motive; anything that can be recalled.

Subconscious Records All. The subconscious, from which intuition springs, is characterized by common sense and discrimination. Our personality, whether good or bad, is what lies in our subconscious. Experiences of youth, lying in our subconscious and affecting our every thought, may contribute toward great achievement or disaster.

Psychoanalysis tries to determine these hidden impressions of experiences and bring them into the conscious so they can be reformed by logic to release our personalities from their bad effects. Apparently the conscious mind can decide that something in the subconscious that is disturbing the personality can be no longer disturbing, providing the conscious knows what it is that is causing the disturbance.

Avoiding the language of Freud, it might be said that this disturbing factor is by some technique brought from the deep recesses of the unconscious into the light of the conscious. Here, it is disclosed not to be the monster imagined and thereby is no longer frightening to the personality.

Thought Frequency. The unconscious mind is directed and excited by the intensity of the thought sent to it by the conscious. It would seem that the repeated direction of a certain thought into the unconscious might make that thought more important in the unconscious. And if it is a conventional thought it could well interfere with the formation of new ideas contrary to it. This seems to be in some degree true. However, the intense direction of a large number of thoughts, part of which are highly speculative, into the unconscious, gives the workshop of the mind good materials with which to work. This offers a large number of possible combinations by which new ideas may be produced. In practice, this usually works.

That Sudden Illumination. Intuitive ideas coming from the unconscious are usually called illuminations, for they so clearly show the answer to the problem under consideration and come suddenly and at unexpected times in a flash.

The well known story of Archimedes' concerning his discovery of how to determine the purity of the golden crown illustrates such an illumination. This ancient mathematician, scientist and engineer had been commissioned by King Hiero II to determine if a crown he had obtained

Intuitive ideas come at sudden and unexpected times . . .

was of agreed purity, it being suspected that the artist had added too much alloy. No doubt Archimedes' consciously thought long and intensely to no avail. To gain rest and relief from his mental efforts he went to a public bath. While relaxed he suddenly thought of putting the crown in the water; for like his body, it would displace its volume of water and weigh less by the amount of water displaced. He was so excited he forgot to put on his clothes but ran through the streets shouting, "Eureka! Eureka!" which meant, I have found it! I have found it!

Emotion plays an important part in the preparation of the mind for inventive thought and is a product of the subconscious work done along with the idea. Daunou stated, "In sciences, even the most rigid ones, no truth is born of the genius of an Archimedes' or a Newton without a poetic emotion and some quivering of intelligent nature."

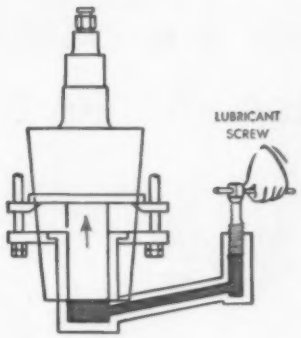
Experienced by Many. Some successful inventors I have known, claim they received revelations from God in making their inventions. Such is the intensity of the illumination sometimes experienced; everything occurs without volition as if from the divine. It could be said that an inventor is a person who allows the inventive process to realize its purpose through him, that the invention comes out of the void.

Benjamin Franklin, who was a great inventor, believed that he had been often instructed in his dreams concerning the issue of events. No doubt he thought they were from the divine, however, Frued said that the dream is the royal road into the unconscious. So, they may have been intuitions from the unconscious mind.

Future chapters on fundamentals and on system will disclose more fully how to obtain illumination. Truly great inventions are usually made with illumination, but do not be discouraged if you do not experience it; a large proportion of the successful intentional ones are made with little if any of it.

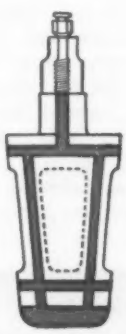
A Glance Back. More detailed discussion of the ideas presented here will be included in later articles. In order

The perfect application of a principle



The lubricant system in the Rockwell-Nordstrom valve is a closed hydraulic system acting much like the two pistons shown on the facing page. Instead of having a separate piston to "charge" lubricant into the valve, the screwed lubricant fitting at the top of the plug acts as the first piston. When lubricant is forced through the fitting by a pressure gun or if the lubricant screw is manually turned down, hydraulic force is magnified and forces lubricant through the channels in the plug.

The plug then acts in much the same fashion as the second piston. A shot of lubricant from a pressure gun or a few turns of the lubricant fitting minutely unseats the plug upwards against the resilient shoulder seal, freeing the plug for smooth, easy turning.



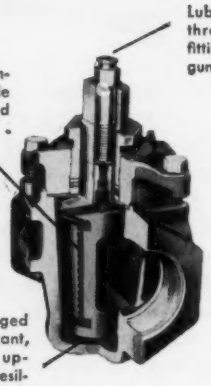
(Continued on next page)

(advertisement)

(Continued from preceding page)

Here's why Rockwell-Nordstrom valves work better, easier and cost less to use, thanks to

$$\triangle F/A = \triangle p$$


Lubricant injected through Rockwell fitting by pressure gun.
Lubricant through channels in plug forms double pressure seal around each valve port . . . leakage eliminated.
Lubricant chamber, charged with pressurized lubricant, counterbalances plug upwards against slightly resilient shoulder seal. Plug can't be stuck in seat . . . instant, dependable operation.

The drawing above shows how lubricant in Rockwell-Nordstrom valves assures the bottle tight shut-off, smooth, easy operation and unmatched dependability that users have learned to expect over the past forty years. Rockwell-Nordstrom, the *original* lubricated plug valve, is also the world's most complete line. They cost no more to buy, often less, than ordinary valves. Whatever your valve needs, there is a Rockwell-Nordstrom valve that will do the job better, longer and at lower cost. If you'd like to know more about these valves or if you'd like to talk with a Rockwell field sales engineer, write Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY

for you to better understand your own mind and thinking, I now suggest you reread this article one sentence at a time. Stop after each to think what ideas come to you and make note of them. Then, as you read on, see how many of them show up in later chapters and see how we agree. Test yourself thus and think about what the results indicate concerning your ability to use imagery and to learn from your surroundings.

One very excellent method for exercising your imagination now would be to go ahead and write what you anticipate I am going to include in the following articles. Another would be to imagine you are equipping your mind as a laboratory for the research which most interests you and list many of the important mental items needed; check those you have and determine when, how and where you can obtain the others. It should prove interesting and profitable to you to keep such a list for frequent review and revision.

In Part 3 which will appear next month, Mr. Gilmore will explain such highly interesting topics as:

1. **Preparation for invention.**
2. **Setting the stage for inspiration and illumination.**
3. **Invention by accident.**
4. **Letting the subconscious take over.**
5. **The intuitive idea.**

About the Author

Forrest E. Gilmore was an engineering consultant and patent administrator at Phillips Petroleum Co.'s Refining department before his retirement in January, 1958. A consultant on process engineering, he was a trouble shooter at various refineries. He also promoted patent ideas and taught engineers how to invent while with the Liaison Refining department and Patent division.

Gilmore

Gilmore began his engineering career after receiving a B.S. degree in civil engineering from Kansas State College in 1916, and graduating from the School of Military Aeronautics at Austin, Texas, in 1918. That same year he became a consulting engineer in the natural gasoline field for Frank T. Peterson & Co. of Tulsa.

In 1921, Gilmore formed the Forrest E. Gilmore & Co. Consulting Engineers, which designed and constructed ten gasoline plants in three years. It was then merged into the Forrest E. Gilmore Co. of Calif., of which Gilmore was executive vice president and manager. This company was taken over by Forrest E. Gilmore Co. of Del., in 1926, and 13 gasoline plants were built. In 1928 he sold his interest in this company and formed Airolene Gasoline Co.

In 1932, while continuing as president of the Airolene and Philmore Gasoline companies, he became president of the Frigid Transportation Corp., a corporation owned principally by The Standard Cap & Seal Corp. There he met Harold E. Talbott, chairman of the board, and Walter P. Chrysler. In 1938 they pursuaded him to head an oil exploration company, Black River Oil Co., which Chrysler had organized. However, Chrysler died and the company was dissolved.

Gilmore then represented Talbott in connection with some small oil properties in Texas. In 1939, the very low price of natural gasoline caused operation of Airolene Gasoline Co. plant to be unprofitable and it was discontinued.

In 1941, Gilmore joined Phillips Petroleum Co. in the Gasoline department. Through the years he held posts as coordinator, administrative assistant to the vice president, assistant superintendent of operation, assistant chief processing engineer, engineering consultant, and patent administrator of the Refining department.

STOP STALLING Next Winter

ICE-CONDITION YOUR GASOLINE FOR WINTER DRIVING NOW

Use UNICOR®-LHS—give customers sure-fire prevention of carburetor icing. Why take chances with your reputation next winter? Make sure your gasoline is safeguarded against carburetor icing. Give it sure protection with UOP's amazingly effective new anti-icing agent—UNICOR-LHS!

UNICOR-LHS added to your gasoline keeps cars rolling, customers happy. Convenient and economical to use, this fast-acting new anti-icing additive can be introduced anywhere—refinery, bulk plant or filling station—at less than half the cost of ordinary anti-icers. Furthermore, UNICOR-LHS retains its effectiveness indefinitely after adding to gasoline.

One of a widely-used line of UOP inhibitors and additives for improving liquid fuels and protecting equipment, you can depend on UNICOR-LHS to do the job—to prevent carburetor icing, stop stalling.

For samples or commercial quantities, and how-to-use-it information, write:

UNIVERSAL OIL PRODUCTS COMPANY

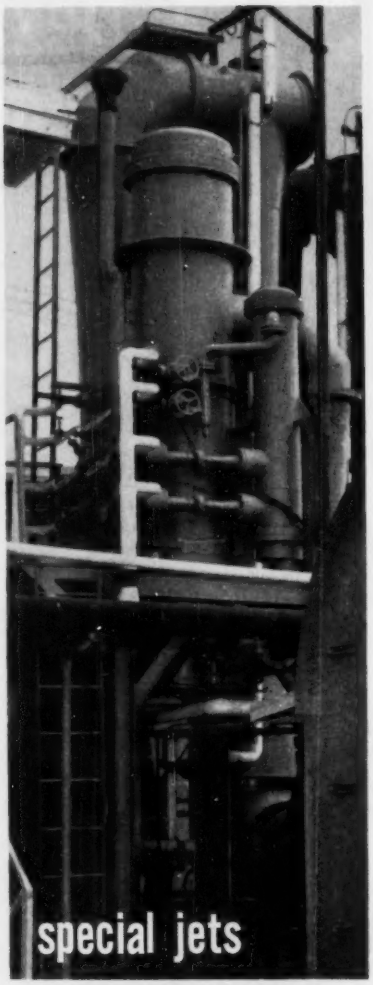
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

UNICOR-LHS OFFERS THESE 6 BIG ADVANTAGES

1) MOST POTENT anti-icing agent, not just a de-icer. Prevents stalling due to ice formation—40 times more effective than alcohol types. **2) NO DILUTION** of gasoline. Used in low concentration, causes no significant loss in BTU value of gasolines. **3) CONVENIENT, ECONOMICAL.** Less than half the cost of ordinary anti-icers. Applied anywhere—refinery, bulk plant or filling station. **4) INSTANTLY MISCIBLE** in even lightest components of high vapor pressure winter-grade gasolines, is not water soluble. **5) PREVENTS RUST** and corrosion all along the line—from refinery processing equipment through distribution and storage facilities. **6) PROVIDES FULL PERMANENT PROTECTION** until fuel is burned.

IMMEDIATELY AVAILABLE—samples, commercial quantities and information on most economical way to use.

This diagram shows how thin coating of ice on carburetor valve shuts off gasoline mixture, causes idling engine to stall. UNICOR-LHS prevents such ice formation and stalling.



for special jobs by JET-VAC

This 5-stage Jet-Vac ejector is one of the largest ever built. It has to be — for its job is to power a high vacuum wind tunnel at a leading university, where rocket models are tested under conditions met at high altitudes and supersonic speeds. Its capacity: 75,000 cfm at 100 microns.

WHAT'S YOUR EJECTOR PROBLEM?

Write today for our free fact-packed folder, with full information on our many services.

JET-VAC

THE JET-VAC CORPORATION

400 Border St., E. Boston, Mass., LOgan 7-2200

A MEMBER OF ARTISAN INDUSTRIES

Steam Jet Vacuum Ejectors • Steam Jet Thermo-Syphons Hydro Jet Ejectors • Thermo Compressors • Special Process Jets • Mixing Jets • Draft Inducers • Vacuum Refrigeration • Barometric and Surface Condensers Venturi Desuper Heaters • Fume Scrubbers.

As Management Sees It . . .

As a Supervisor— How Good Are You?

Evaluate yourself by studying the attitude, level of instruction and performance of your workers

Robley D. Stevens, Management Consultant

WHY WERE you chosen to become a supervisor in your refinery? Do you differ in many respects from other members of your refinery personnel? Do you really have the potential ability and characteristics required of a good supervisor? You should spend some of your thinking about these questions and what answers you get.

Probably more than any other single factor, your success is determined by your attitude toward instructing your workers and your desire to do a competent job. As a supervisor you should learn to benefit from your mistakes and constantly change for the better. In this way you can, and will grow managerially.

Workers in your refinery must acquire the knowledge and skill required to preform their jobs. They look to you for instruction and guidance. Thus, you should be thoroughly familiar with the requirements of your own supervisory position. Right now is a good time to start sizing up your job and determining what is expected of you by your refinery.

Personal Qualifications. Certainly no refinery supervisor is born with any such complex skills as those required in supervision. Good supervisors get that way primarily through study and hard work but few manage to capitalize on their native abilities to their full extent. How successful you are depends on your constant desire to develop your supervisory abilities to the maximum degree.

Supervision is a highly specialized work. It is not a matter of merely handing out facts and information. Rather it is making use of certain refinery management methods and techniques—instructing your workers to always do a productive job.

One important phase of your job is to arouse in your employes a genuine desire to work. This often involves showing them that the personal rewards they get is worth the effort. In a sense, then, you must be a salesman, and three of your most desirable qualities should be sincerity, enthusiasm, and patience. You should also take advantage of every opportunity management offers you to acquaint yourself with its objectives and problems. Then devote some thought on how to go about achieving or solving them.

One advantage of your job is that it continually offers challenging problems which demand your attention. The action you take which results in a correct solution of your problem constitutes a growth in your stature. Along these same lines, your workers, too, will help keep your job from becoming monotonous. You may do your supervisory job over and over, but you will never do it twice in the same way.

What all of this boils down to is that you are engaged in real personnel work because you are constantly dealing with people. And this provides you with an opportunity to develop your ability to get along with them. That all major oil companies consider this ability a major asset is indicated by the efforts they expend in developing it in their supervisors and prospective supervisors. As a refinery supervisor, you have an opportunity to study personnel at first hand, to learn more about personnel principles through doing, and to practice the art of getting along

For more data on advertised products, use Readers' Service Cards, last page.

A clad "sandwich" being assembled prior to hot rolling. Claymont Stainless-Clad Plates—5 to 50% stainless inseparably bonded to carbon steel backing—offer the corrosion and abrasion protection of stainless steel plus the economy of carbon steel. This is another of the many steel plate products available from Claymont's integrated mill.

by d'Arazien

CLAYMONT
STAINLESS-CLAD PLATES

CF&I

CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates • High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products • Large Diameter Welded Steel Pipe

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

Plant at Claymont, Delaware • Sales Offices in all Key Cities

5788

Ability to BUILD!

. . . progress powered by engineering know-how

CRUSHING FORCE of earth-moving monsters, curves in a complex feasibility study, coursing of chemicals in a new process — these are elements of engineering know-how.

Men of the Fish Companies combine idea freshness and system to create reality from ideas. If design is a problem . . . if time and topography oppose, the know-how of engineering by Fish drills to the heart of the problem in the oil, gas and chemical industries.

Fish builds in all dimensions everywhere.

THE FISH ENGINEERING CORPORATION
HOUSTON
AND ASSOCIATED COMPANIES

FISH SERVICE CORPORATION • FISH NORTHWEST CONSTRUCTORS, INC.

For more data on advertised products, use Readers' Service Cards, last page.

with people. This simply means you do have a chance to develop your own leadership ability.

What you make of this opportunity depends solely on you. If you abuse your authority you will fail to win the confidence, loyalty, and cooperation of your workers. When you undertake to help your refinery personnel gain the skills, knowledge, and understanding essential to its management, you assume greater responsibilities in your own job. In any event, your progress as a supervisor is up to you.

Pattern for Instruction. Years of experience and research have shown that refinery workers work more efficiently when their activities are guided by supervisors with understanding and an insight to problems.

Regardless of the type, level, or peculiarities of your workers, it is desirable that your supervisory instructions begin with what they already know; this is a basic principle you must keep in mind. You should treat your workers as individuals and apply refinery procedures that will work best among various backgrounds, abilities, and experiences. Knowing why a worker is doing a particular job is of much value to him and you. Knowing where he is heading in his work-assignment has its proper purpose.

Your workers should be given the opportunity to handle refinery equipment, apparatus, and tools properly in a working situation. Their ability to apply their knowledge and experience is based on how well you instruct and supervise them. For example, the question, "How did you do this job?" might be stressed more than "What did you do?"

Of course, understanding of refinery procedure and instructions is necessary in the development of any worker's ability; the techniques you use may vary with the situation. It is important that each worker be able to judge his job performance, as this is an indication that management's objectives are clear to him. You should handle your supervisory job with a realization that you will give your workers every opportunity to develop them in the work situation.

Your Planning. If you are scheduled to make a speech, many workers are often involved, and you should make adequate plans. You may have the "gift of gab" but you still should plan it. The subject, introduction, body of your speech, and summary are all important. As you plan, it's a good policy to make a few notes so you will bring out all pertinent points to your workers. Adequate instruction is more important than the fact that you are going to make a speech.

Whatever type of instruction you are doing in your refinery, part of your planning has probably been done for you by your management. You should base your plan on careful diagnosis like the doctor writing a prescription for his patient. Similarly, state management objectives clearly and of course specifically. A good instruction plan is more than just an outline of what you know and what your workers should learn. Having such a plan should prevent you from "getting off the beam" and omitting essential points.

Not All Understand. A good supervisor looks upon his workers as individuals. Everything you do and say adds to their opinion of you as a person, and influences the way they react and respond to their job.

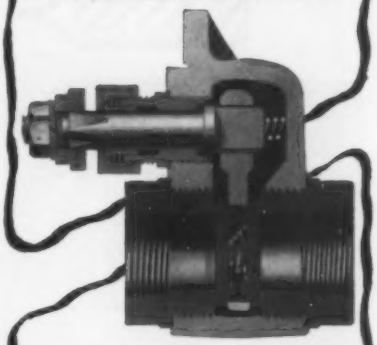
All refinery workers do not always understand instructions or explanations the same. If you are to get them to do a good job, you should give each one an opportunity to gain understanding in his own way. You can do this merely by encouraging your workers to participate. Get them into the act at every reasonable opportunity. Your discussion of refinery work problems should be a pooling or interchange of ideas of all employes.

One of your biggest tasks as a supervisor is to encourage and stimulate your workers to make their contribution to refinery undertakings. And you should encourage each worker to check himself because he knows more about himself than you do, and he has more time to work on himself during refinery employment. Your process of instruction is one of making meanings clear, telling and showing your workers how to do things and how to apply management principles.

The effectiveness of your instruction can be determined only by the results it brings in your refinery. You can check on this effectiveness by observing the effect it has on your workers.

You should not let your supervisory instructional problems accumu-

FULL-FLOW
Okadee
VALVES
NON-LUBRICATED



POSITIVE
STOP
FOR
- Steam
- Air
- Ammonia
- CO_2
- Gasoline
- Propane
- Styrene
- Butadiene
- Lube Oils
- Jet Fuels

Available in Stainless Steel or Steel, Chemically Nickel Coated

You can select Okadee Valves for flow by pipe size—and get full-flow and positive shut-off with virtually any liquids and gases.

Quick-opening, metal-to-metal disc valves and seats require no lubrication—virtually no maintenance for hundreds of thousands of operations . . . Real valve *performance* and *service*.

FACTS AND FIGURES
. . . on Okadee Valves will be sent promptly on request. Sizes ½" to 8"; A.S.A. dimensions; screwed or flanged. Valve seats and discs Stellite or stainless steel; your choice of operators.

- Write for Bulletin CP6

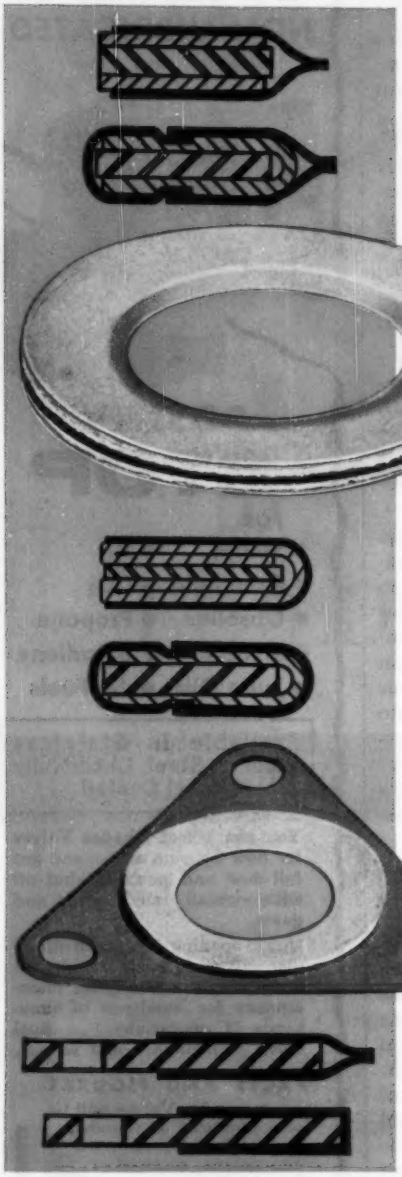
Okadee COMPANY
332 SOUTH MICHIGAN AVENUE
CHICAGO 4, ILLINOIS

For more data on advertised products, use Readers' Service Cards, last page.

Chemiseal® Gaskets

. . . with protecting Jackets of du Pont TEFLON, are impervious to all known chemicals*. They are made with a variety of filler constructions to suit every connection problem—every pipe and nozzle material requirement—whether glass, ceramics, stainless, Karbate, Haveg, glass-lined steel, etc. That is why Garlock 8764 Chemiseal Gaskets have become the standard choice of the process industries.

*Excepting molten alkali metals, fluorine at elevated temperatures and complex halogen compounds.



Illustrated at left is the standard Chemiseal slit-envelope Ring type Gasket designed to fit inside the bolt circle of flanges drilled to 125 lb. standards and made for all standard pipe sizes up to 10" I.D. Stocked for all Pfaudler and Glascote standard nozzle sizes from 1½" to 10" I.D.

Also available as shown with double jacket protecting O.D. as well as I.D. against corrosion.

Illustrated at left is Chemiseal formed-shield Ring type Gasket for large diameter glass-lined steel or special material nozzles and irregular shaped openings. Also available as shown with double formed-shield protecting both O.D. and I.D.

Illustrated at left are Chemiseal Gaskets with full face filler with bolt holes, for standard Corning conical flanges. These gaskets seal with unusually low bolt loads. Shown are both slit-envelope and milled-envelope types.

Milled-envelope type fits flush with the pipe I.D. and provides minimum impedance to flow. This type Jacket is supplied either with full face filler or with filler to fit inside bolt circle on standard 125 lb. flanges.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write for Bulletin AD-154.

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

late. You should attack each one as it comes along from your refinery management and is identified. Some supervisors hide their problems because they are afraid to let someone find out they are having difficulty. Look to your management for help. As a supervisor, you should be producing reasons for your success, not excuses for your failure.

Learn By Doing. Practice, performance, application and refinery activities are necessary phases in the development of a worker's skill. Only by giving your workers sufficient experience in simulated conditions can you expect him to produce to the maximum extent. A tryout experience in a job is essentially a matter of learning by doing and certainly should be used in your refinery.

One worker can waste his own time, and perhaps that of others, but you the supervisor can waste everyone's time by bad management and poor instructions. It is seldom profitable to insist that a worker learn all about his job before he does it. One effort to do the job makes it much easier to understand all principles involved. Thus, you should guide your workers in both refinery performance and application. Skills can be acquired only by doing. They can be acquired only if your workers engage in doing or practicing the act. Of course for safety reasons, you must evaluate how far your workers have progressed and what additional instructions they require.

How effective is your supervision? The value of your performance and application in your refinery lies in the results it brings about. Ask yourself this question: Did my workers perform their job effectively? By so doing you are in a position to analyze your instructions.

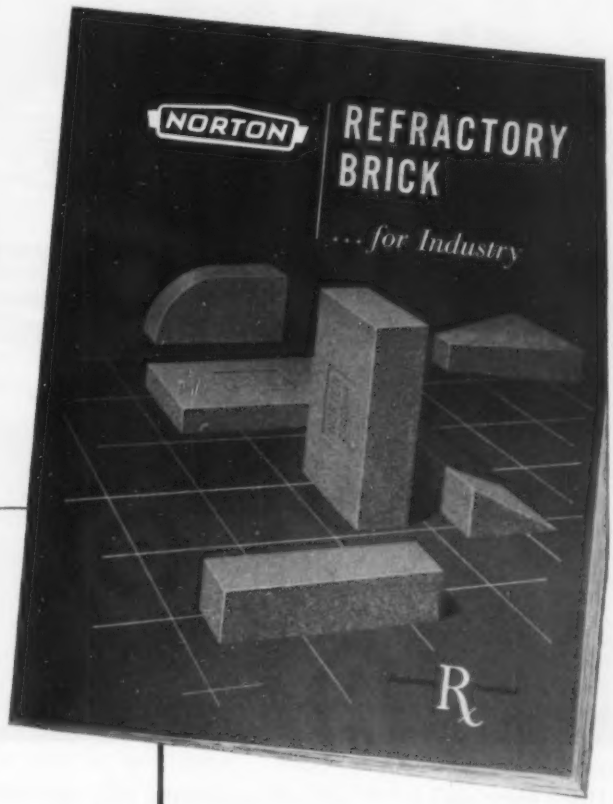
Motivate Willingness. As a refinery supervisor, you should be constantly alert to adopt management procedures which will make your workers better. Good motivation creates a readiness, an eagerness, a desire from your workers to learn and produce more.

Rewards may be tangible or intangible. Your workers may be driven by such things as financial gains for themselves, or loyalty to you their supervisor. You should be aware of the various types of inducements you can offer and be ready to use the

For more data on advertised products, use Readers' Service Cards, last page.

Send for this

New Booklet to Help Improve Your High Temperature Processing



Covers Norton refractory brick applications, characteristics, chemical analyses — includes helpful data on materials of construction for temperatures up to 4,400°F.

This new, 24-page Norton booklet can be a dependable guidebook for your selection of the refractories you need to improve production and cut costs in high temperature processing.

Eight Norton-developed refractory materials are covered: ALUNDUM* "T" 87% Alumina; ALUNDUM "A" 99% Alumina; ALUNDUM "L" 99% Insulating Alumina; CRYSTOLON* "G" Silicon Carbide; CRYSTOLON "N" Nitride Bonded Silicon Carbide; MAGNORITE* "K" Fused Magnesia; Zirconia "H" Dense Zirconia; Zirconia "I" Insulating Zirconia.

All essential details are listed, such as: how each material is produced . . . important properties, characteristics and chemical analyses . . . shapes of brick and other molded products that are available . . . representative applications . . . packing methods that assure safe arrival.

Also included are charts and tables of brick shapes and sizes, thermal expansion and conductivity graphs, and a temperature conversion chart.

Norton refractories — engineered and prescribed for the widest range of applications — have helped many users save time and money. The ℞'s described in *"Norton Refractory Brick . . . for Industry"* may do the same for you. Write for your copy to NORTON COMPANY, Refractories Division, 469 New Bond Street, Worcester 6, Massachusetts.

NORTON
REFRACTORIES
Engineered . . . ℞ . . . Prescribed
Making better products . . . to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

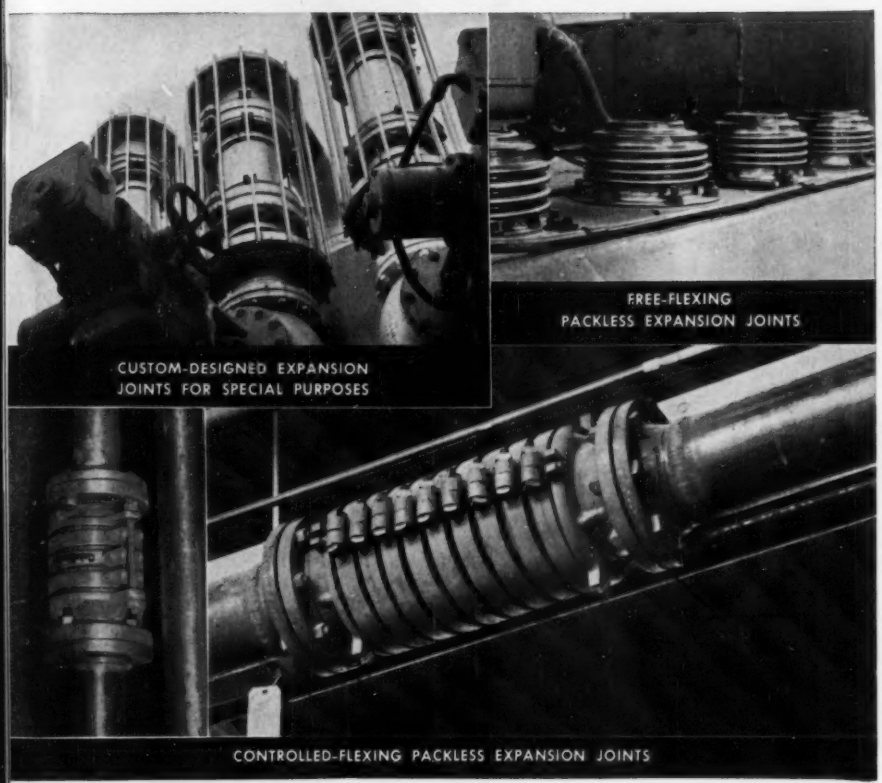
NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.

The answer to your
pipe expansion problems

Flexon®

Expansion Joints



Here's where you'll find the skill and experience to guide your selection of ways to take care of pipe motion problems. Flexon engineering gives you more – more research, more metallurgical care, more service, more "standards" to select from. And all of these add up to expansion joints that you can *install and forget!* Free-flexing and controlled-flexing; pressure-balanced joints and other special designs; all in stainless steel, monel, and other workable alloys.

Member of Expansion Joint Manufacturers Association

Why settle for *less* – when experience shows that you get *more* of everything from Flexon?

TODAY — write for your copy of this 28-page Flexon Expansion Joint Design Guide

EJ-219

Flexonics corporation

EXPANSION JOINT DIVISION • 1336 S. THIRD AVENUE, MAYWOOD, ILLINOIS

EXPANSION JOINTS · METAL HOSE · NON-METALLIC HOSE · BELLOWS · AIRCRAFT COMPONENTS

ones that will prove most effective in each situation. Of course, immediate gains are more appealing than those which will come at some far or indefinite time. Look for fruit that can be harvested immediately, right in your own refinery.

You should convince them that their take-home pay is worthwhile and the efforts they expend are being suitably rewarded. Be quick to point out that promotions, better jobs, and higher pay await them if they are skillful.

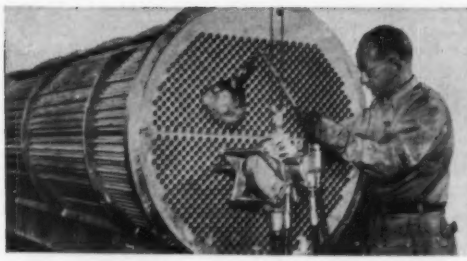
Of course, you will always run up against various obstacles which you must overcome if you are to keep your workers producing. If, for instance, one employe is experiencing a feeling of antagonism toward some refinery rules, try to explain to him their purpose. If a worker feels that he is being assigned more than his fair share of a job, his interest may wane. If, after checking, you find such a complaint is legitimate, you must correct the condition. Emotional upsets and worries can keep a good worker from developing. You may do a great deal to help him by being friendly.

All the resources at your command should be used to make your supervisory instruction real and vital for your workers. Your ability in using the various methods will often enable you to choose one method in preference to another for a particular purpose.

Evaluate Yourself. "How am I doing?" You, a refinery supervisor, will naturally want to answer this question. Is your supervisory instruction really getting across? Are your workers really doing their jobs well? could they do more if you use different refinery management methods, procedures, or techniques? Are you reaching all your workers?

To find out whether your supervisory instruction has been a success or failure, you need to evaluate what your workers are doing. Your success is reflected in their attitude, level of instruction and performance. If your team of workers is functioning smoothly with everyone pulling for the same high standards then you've earned the right to pat yourself on the back. If this is not the case, then you had better devote a little time to retracing your steps to find out what went wrong.

Evaluate yourself. As a supervisor —how good are you? ##



CONDENSER AND HEAT EXCHANGER CLINIC

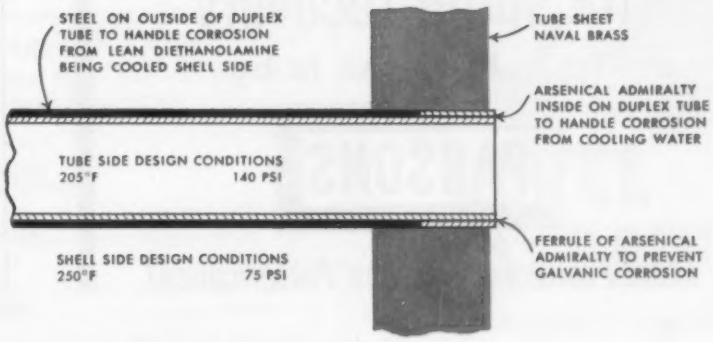
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, N. Y.

Duplex tube applications increase as corrosion and temperature-pressure problems grow more complex

New and improved processes in the chemical and petroleum industries—advancing design in power equipment both ashore and afloat, involving ever higher temperatures and pressures—are calling for more and more duplex tubes.

Working closely with both users and manufacturers of heat-exchange equipment, The American Brass Company is expanding its facilities to provide these special-purpose tubes in the combinations of metals and in the sizes and gages to meet new and growing needs.

Dual corrosion problems. Anaconda Duplex Tubes have been most often used to meet situations involving dual problems of corrosion. They are made by drawing tubes of copper or a copper alloy either inside or outside of steel tubes. However, they can be furnished in any combination of metals, including copper or copper alloys with other nonferrous metals or steel in a wide range of diameters and wall thicknesses.

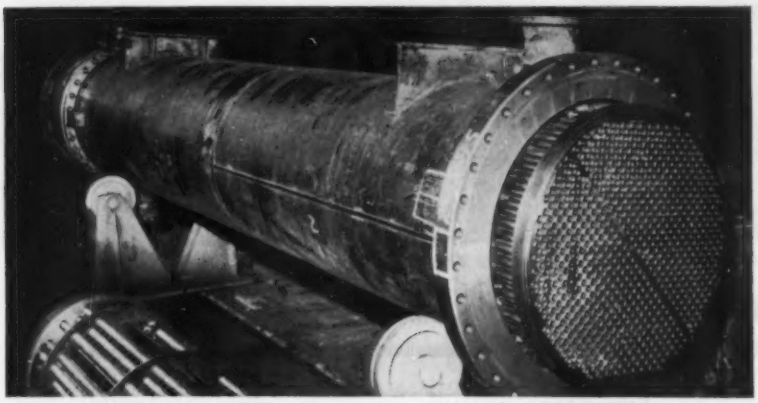

STEEL ON OUTSIDE OF DUPLEX TUBE TO HANDLE CORROSION FROM LEAN DIETHANOLAMINE BEING COOLED SHELL SIDE
TUBE SHEET NAVAL BRASS
ARSENICAL ADMIRALTY INSIDE ON DUPLEX TUBE TO HANDLE CORROSION FROM COOLING WATER
TUBE SIDE DESIGN CONDITIONS
205°F 140 PSI
FERRULE OF ARSENICAL ADMIRALTY TO PREVENT GALVANIC CORROSION
SHELL SIDE DESIGN CONDITIONS
250°F 75 PSI

SKETCH SHOWING CONSTRUCTION of Anaconda Duplex Tubes used in the cooler designed and built by Yuba. Tubes are ¾" O.D. x .065" wall x 16'1⅛" long. The 1 1/16" thick tube sheets of Anaconda Naval Brass are 31⅝" in diameter and 35⅞" in diameter.

For extra strength. More and more Anaconda Duplex Tubes are being used in those applications where internal or external pressures—or the pressure temperature combinations—are too great for a nonferrous tube alone. In this case the nonferrous tube is selected for the chemical properties required for the more corrosive fluid handled; and the steel tube gives the needed strength.

U-bends. Duplex tubes can be readily bent to form the hairpin or U-bend tubes required for the compact U-bend tube design so advantageous in heat exchangers where wide temperature differences exist in the unit.

Technical Assistance. Specialists at the American Brass Company are constantly working with manufacturers and users of heat-exchange equipment, helping to solve process problems. This experience is available to you. For more detailed information on Duplex Tubes, U-bend Tubes, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5879



A LEAN DIETHANOLAMINE COOLER using Anaconda Duplex Tubes (see detail sketch above) designed and built by Yuba Heat Transfer Division of Yuba Consolidated Industries, Inc., Honesdale, Pa. This unit will cool Lean Diethanolamine at the new 19,000 barrels per stream day delayed coker designed, engineered and being constructed for Socony Mobil at Paulsboro, N. J. by The Lummus Company.

ANACONDA®
TUBES and PLATES for CONDENSERS & HEAT EXCHANGERS
Made by
THE AMERICAN BRASS COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

Since 1952 approximately

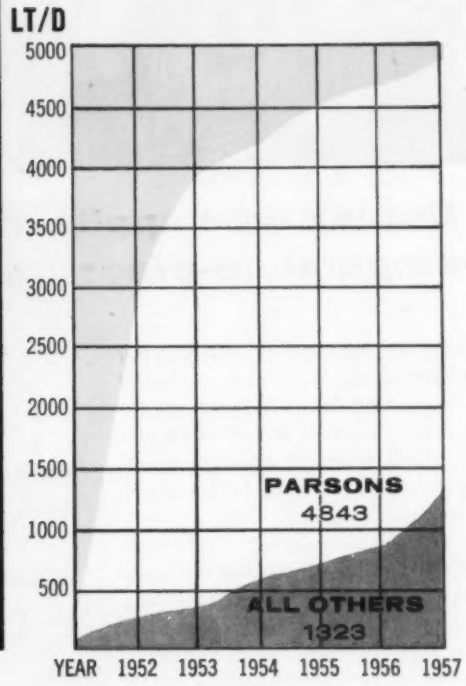
80%

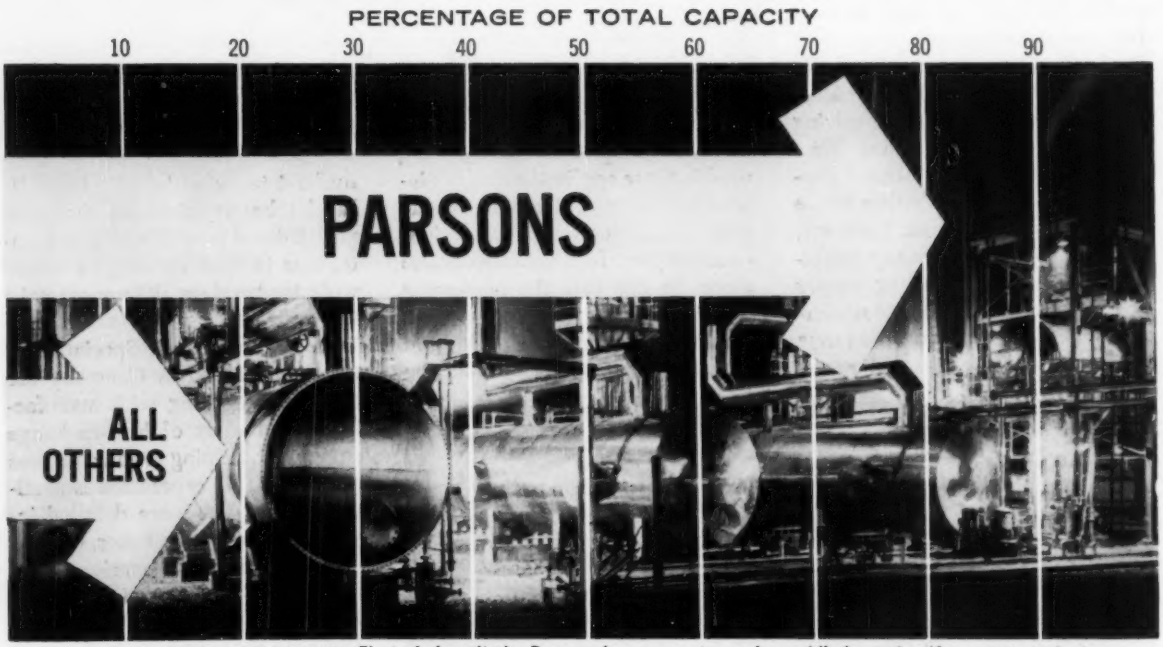
of the world's capacity for sulfur recovery

from H_2S gas is by

PARSONS

Proof Positive of Parsons' Performance!





LACQ, FRANCE: First of six units by Parsons is now on stream in world's largest sulfur recovery plant.

PARSONS means leadership

THE RALPH M. PARSONS COMPANY

ENGINEERS • CONSTRUCTORS
LOS ANGELES

NEW YORK
PASADENA
WASHINGTON

ANKARA
BAGHDAD
BEIRUT
JEDDAH
KARACHI
MADRID
NEW DELHI
PARIS
TORONTO

If Oil Could Speak

If oil could speak it would have many fascinating truths to tell the non-oil public—truths that would win thousands of new friends for the oil industry.

But, oil can't speak—you can. You, as an individual, can win many new friends for the oil industry if you will pass the true facts on to your non-oil industry friends.

Here are some of those true facts. They are being presented for one purpose: To keep you posted on your industry, so you can tell the story oil is unable to relate.

Read these facts. You will find them informative—and interesting.

What Does It Cost to Increase Gasoline Quality?

This year's cars pack more power than ever, with compression ratios averaging 9.5:1—half a compression number ratio higher than 1957 models. Roughly, an increase of one-half a unit in compression ratio means that refiners must up gasoline quality by one full research-octane number. Refining crude oil into superior products consumers demand is a high taking 70 to 75 percent of the sum refiners spend on new construction.

Boosting gasoline quality alone will cost the oil industry an estimated $175 million in 1958.

Is the Oil Industry Monopolistic?

By no means! The one logical way to find the answer is to see if one company or a small, noncompetitive group controls the various phases of competition:

Competition in Production. No one company has more than 7 percent of total domestic crude oil production and, further, the largest 16 companies have less than half (49.6 percent).

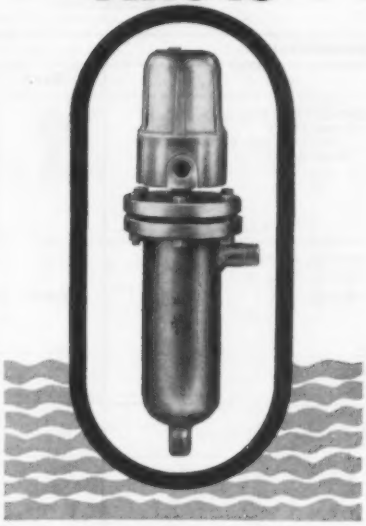
Competition in Refining. No one company controlled more than 10.4 percent of the total oil processed at refineries in 1956, and the largest six had less than half (46.2 percent).

Competition in Marketing. Most people personally observe daily the high degree of competition in marketing in the wide choice of gasolines at various prices offered by service stations. House dwellers are familiar with the large number of heating oil dealers competing for the home heating market. Not so easily seen, but possibly even more intense, is the rivalry in the wholesale markets where fractions of a cent sway transactions. There are over 16,000 jobbers and distributors of oil products.

What about other forms of competition, say research? This is the newest and one of the fastest-growing forms of competition. Increasing emphasis is being placed on improvement of long-standing oil products and development of new ones in order to maintain or improve the individual oil company's market position. Higher quality products is the reward to the consumer.

Thus, in production, refining, marketing and research the presence of competition is clearly apparent. Large, medium, and small oil companies supply the products that fuel the nation's economy. The factual record shows how the competition that prevails in the oil industry best serves the consumer.

This is



LEVEL MASTER®

The UNFAILING Liquid Level Control!

The ability to function with *continuous, sensitive control* with liquids is the standout feature of Level Master. The "brain" of Level Master is the unique Bell Magnetic Proximity switch incorporating a permanent Alnico V magnet that responds instantly to changes in liquid level!

- *Models for all types of liquids.*
- *Horizontal, vertical, external mountings.*
- *Precision engineered for long life operation.*

For full information consult your Level Master representative or write directly to:

JO-BELL PRODUCTS, INC.

5456 W. 111th St. • Oak Lawn, Ill.

Phone GArden 5-0240

Jo-Bell Products, Inc. Dept. C
5456 W. 111th St., Oak Lawn, Ill.
Send full information on Level Master and name of nearest representative.

My name_____

Company_____

Address_____

City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.

PROPERTIES OF ASTM PRESSURE VESSEL STEELS—DATA DEVELOPED

WORLD'S LEADING PRODUCER OF ALLOY, ARMOR, CLAD AND

HIGH TEMPERATURE STEELS

ASTM DESIGNATION	A-204 Mo			A-387 (Supersedes A-301) Cr-Mo				
	Grade A	Grade B	Grade C	Grade A	Grade B	Grade C	Grade D	Grade E
COMPOSITION, % based on 1" gage Firebox quality. (Values are max. unless otherwise indicated.)	C .18, Mn .90, P .035, S .04, Si .13-.32, Mo .41-.64	C .20, Mn .90, P .035, S .04, Si .13-.32, Mo .41-.64	C .23, Mn .90, P .035, S .04, Si .13-.32, Mo .41-.64	C .21, Mn .36-.84, P .035, S .040, Si .13-.32, Cr .46-.79, Mo .40-.70	C .17, Mn .36-.69, P .035, S .040, Si .13-.32, Cr .75-1.31, Mo .40-.70	C .17, Mn .36-.69, P .035, S .040, Si .48-1.02, Cr .94-1.56, Mo .40-.70	C .15, Mn .27-.63, P .035, S .040, Si .50, Cr 1.88-2.62, Mo .85-1.15	C .15, Mn .27-.63, P .035, S .040, Si .50, Cr 2.63-3.37, Mo .85-1.15
PHYSICAL PROPERTIES (c) Density, lb./cu. in.	0.283			0.283				
Magnetic Prop.	Magnetic. Some residual magnetism remains.			Magnetic. Some residual magnetism remains.				
PROCESS	Open Hearth or Electric Furnace			Open Hearth or Electric Furnace			Electric Furnace only	
MECHANICAL PROPERTIES	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. Annealed	Fbx. Annealed	Fbx. Annealed	Fbx. Annealed	Fbx. Annealed
Mod. of Elast. in Tension, psi	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶
Tensile Strength, 1000 psi	65-77	70-85	75-90	65-82	60-82	60-85	60-85	60-85
Yield Point, 1000 psi min.	37	40	43	40	35	35	30(b)	30(b)
Elong. (in 2 inches), %	25	23	22	24	24	24	20	20
Red. of Area, % min.							50	50
Typical Hardness, Brinell(c)	140-165	150-180	165-200	140-175	135-175	135-180	135-180	135-180
Impact Str., Charpy Keyhole								
THERMAL TREATMENT	Over 2" gage requires grain refinement by normalizing. Under 2" may be as-rolled or stress-relieved, normalized, or normalized and stress-relieved.			All gages require grain refinement by either annealing, or normalizing and tempering. No quenching in liquid medium permitted.			All gages require annealing or normalizing and tempering.	
FABRICATING PROPERTIES(c) Formability	May be hot or cold formed.			May be hot or cold formed.				
Weldability	May be manual or machine welded. For all gages preheat and elevated interpass temperature are desirable. Stress relief desirable. Peening may be necessary for gages over 1 inch.			May be manual or machine welded. For gages under 4" preheat and elevated interpass temperature are desirable. Stress relief desirable. Peening may be necessary for gages over 1" thick.				
AVAILABLE FORMS	Plate form only. Flange quality to max. gage of 2" incl. Grades A and B, Fbx. quality to max. gage of 6" incl. Grade C, Fbx. quality to max. gage of 4" incl.			Plate form only. For Grades A, B and C Flange quality to max. gage of 2" incl., for Fbx. quality to max. gage of 6" incl. For Grades D and E to max. gage of 6" incl.				
USES	Boilers, other pressure vessels for service up to 1000°F inclusive.			Boilers, other pressure vessels. Grade A for service up to 1000°F, Grades B, C, D, & E for service up to 1200°F inclusive.				

ABBREVIATIONS: S.R., stress relieve; Fbx., firebox quality; Flg., Flange Quality

(a) Charpy Keyhole values are those required when specification made to ASTM A-300 specification.

(b) Values for these materials are yield strength (1000 psi, min.).

(c) Data or properties are not part of ASTM specifications.

PROPERTIES OF LUKENS "T-1" CONSTRUCTIONAL ALLOY STEEL

(trademark)

"T-1" CONSTRUCTIONAL ALLOY STEEL

QUALITY	Composition, %	Mod. of Elast. in Tension, 1000 psi.	Tensile Strength 1000 psi (1" gage)	Yield Strength 1000 psi (1" gage)	Elong. in 2" Min. % (1" gage)	Reduction of Area, % (1" gage)	Typical Hardness Brinell	Impact Str. Charpy Keyhole	Thermal Treatment
REGULAR	C .10-.20, Mn .60-1.00, P .04, S .05, Si .15-.35, Ni .70-1.00, Cr .40-.80, Mo .40-.60, V .03-.10, Cu .15-.50, B .002-.006	30x10⁶	115-135	100 min.	18	50	250-280	—	Water quench and temper
321 MIN. BHN	same	same	—	—	—	—	321 min.	—	same
FLANGE	same	same	115-135	100 min.	18	50	250-280	—	same
FIREBOX	same*	same	115-135	100 min.	18	50	250-280	15 ft. lbs. at −50°F(a)	same
FIREBOX TO ASTM CASE 1204-3	same*	same	105-135	90 min.	17	—	250-280	15 ft. lbs. at −50°F(a)	same

*For Firebox quality, check analysis limit of P 0.035 max. and S 0.04 max. applies.

BY LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

SPECIALTY CARBON STEEL PLATES • HEADS • PLATE SHAPES

LOW TEMPERATURE STEELS							HIGH STRENGTH STEELS					
A-203 Ni					A-353 Low C, High Ni	A-410-57T Cr-Co-Ni-Al	A-202 Cr-Mn-Si		A-225 Mn-V		A-302 Mg-Mo	
Grade A	Grade B	Grade C	Grade D	Grade E	—	—	Grade A	Grade B	Grade A	Grade B	Grade A	Grade B
C .17, Mn .80, P .035, S .04, Si .13-.32, Ni 2.13-2.67	C .20, Mn .80, P .035, S .04, Si .13-.32, Ni 2.13-2.67	C .25, Mn .80, P .035, S .04, Si .13-.32, Ni 2.13-2.67	C .17, Mn .80, P .035, S .04, Si .13-.32, Ni 3.18-3.82	C .20, Mn .80, P .035, S .04, Si .13-.32, Ni 3.18-3.82	C .13, Mn .80, P .035, S .040, Si .13-.32, Ni 8.40-9.60	C .12, Mn .55-1.00, P .040, S .040, Cu .40-.75, Si .08-.37, Ni .47-.98, Cr .44-1.01, Al .04-.30	C .17, Mn1.00-1.45, P .035, S .04, Si .54-.96, Cr .31-.64	C .25, Mn1.00-1.45, P .035, S .04, Si .54-.96, Cr .31-.64	C .18, Mn 1.45, P .035, S .04, Si .13-.32, V .07-.16	C .20, Mn 1.45, P .035, S .04, Si .13-.32, V .07-.16	C .20, Mn .90-1.35, P .035, S .040, Si .13-.32, Mo .41-.64	C .20, Mn1.10-1.55, P .035, S .040, Si .13-.32, Mo .41-.64
0.283 Magnetic. Some residual magnetism remains.					0.286 Magnetic. High residual magnetism remains.	0.283 Magnetic. Some residual magnetism remains.	0.283 Magnetic. Some residual magnetism remains.		0.283 Magnetic. Some residual magnetism remains.		0.283 Magnetic. High residual magnetism remains.	
Open hearth or electric furnace					Open hearth or electric furnace	Open hearth or electric furnace	Open hearth or electric furnace		Open hearth or electric furnace		Open hearth or electric furnace	
Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. Double Normalized	Fbx. Normalized	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled	Fbx. As Rolled
29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶	29-30x10⁶								
65-77	70-85	75-90	65-77	70-85	90 min.	60 min.	75-90	85-100	70-85	75-90	75-95	80-100
37	40	43	37	40	60 (b)	30	45	47	40	43	45	50
25	23	22	25	23	22	24	21	20	23	22	21	20
140-165	150-180	165-200	140-165	150-180	200	135	165-200	180-210	150-180	165-200	165-205	170-210
15 ft. lbs. at −75° F (a)			15 ft. lbs. at −150° F (a)		15 ft. lbs. at −320° F (a)	15 ft. lbs. at −150° F (a)						
Over 2" gage requires grain refinement by normalizing. Under 2" may be as-rolled or stress-relieved, normalized, or normalized and stress-relieved.					All gages require double normalizing.	All gages require grain refinement by normalizing.			Over 2" gage requires grain refinement by normalizing. Under 2" gage may be as-rolled, stress-relieved, normalized, or normalized and stress-relieved.		Over 2" gage requires grain refinement by normalizing. Under 2" gage may be as-rolled, stress-relieved, normalized, or normalized and stress-relieved.	
May be hot or cold formed. Can be manual welded. For gages under 4" preheat and elevated interpass temperature are desirable. Stress relief desirable. Peening may be necessary.					May be hot or cold formed. Can be manual welded. Austenitic electrodes are desirable. No preheat required. Stress relief desirable.	May be hot or cold formed. Can be manual welded. For gages over 2" thick, preheat and elevated interpass temp. are desirable. S.R. desirable.	May be hot or cold formed. May be manual or machine welded. For all gages preheat and elevated interpass temp. are desirable. Stress relief desirable. Peening may be necessary.		May be hot or cold formed. May be manual or machine welded. For gages over ½" preheat and elevated interpass temp. are desirable. Stress relief desirable. Peening may be necessary.		May be hot or cold formed. May be manual or machine welded. For over .15 carbon preheat and elevated interpass temp. are desirable. S.R. desirable. Peening may be necessary.	
Plate form only. Flange quality to max. gage of 2" incl. Grades A and B, Fbx. quality to max. gage of 6" incl. Grades C, D and E, Fbx. quality to max. gage of 4" incl.					Plate form only. Fbx. quality only to max. gage of 2" incl.	Plate form only. Fbx. quality only.	Plate form only. Fbx. quality only to max. gage of 2" incl.		Plate form only. Flg. quality to max. gage of 2" incl. Grades A and B, Fbx. quality to max. gage of 4" incl.		Plate form only. Flg. quality to max. gage of 2" incl. Fbx. quality to max. gage of 4" incl.	
Boilers, other pressure vessels, low temp. applications or elevated temp. up to 1000° F incl.					Primarily for pressure vessels used in low temperature applications.	Primarily for pressure vessels used in low temperature applications.	Boilers, other pressure vessels for service up to 1000° F inclusive.		Boilers, other pressure vessels for service up to 1000° F inclusive.		Boilers, other pressure vessels for service up to 1000° F inclusive.	

Formability	Weldability	Corrosion Resistance	Available Forms	Uses
Cold forming advised. Power requirements 3 to 4 times carbon steel. Springback greater than carbon steel. For bending use liberal radius.	May be manual or machine welded. Moderate preheat and interpass temp. beneficial for restrained joints and heavy gages.	Atmospheric corrosion resistance approx. 4 times that of carbon steel.	Plates up to 10" gage inclusive. Plates up to 6" gage inclusive. Plates up to 2" gage inclusive. Plates up to 6" gage inclusive. Plates ⅛" gage up to 2" gage inclusive.	Heavily loaded (static or dynamic) structural applications. Impact abrasion resistance application. Heavily loaded (static or dynamic) structural applications. same as above ASME Code pressure vessels for temp. from −50°F through 650°F.

This data developed and compiled by Lukens Steel Company, producers of alloy and clad steel plate and heads in the widest range of sizes available anywhere. Depending on gage plates are available in widths up to 195" and lengths up to 720"

For copies of this chart, enlarged to 24"x18", or for further information on the steels described, write to Manager, Marketing Service, 250 Lukens Building, Coatesville, Pennsylvania.

LUKENS

What's Happening . . .

. . . in the Industry

Recent Annual Expenditures for and Current Investment in Property, Plant, and Equipment

Source: Chase Manhattan Bank Bulletin, "Petroleum Industry . . . 1957"

Department	Estimated Expenditures for Property Plant, and Equipment in Past 10 Years						Estimated Investment Dec. 31, 1957 in Property, Plant and Equipment			
	1957		1956		10 Years 1948-1957		Gross		Net	
	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total	$ Million	% of Total
*Crude and Natural Gas Production	4,400	68.8	4,375	72.3	31,540	69.0	27,000	57.0	12,950	52.9
Gasoline and Cycling Plants	125	1.9	100	1.7	935	2.0	1,100	2.3	550	2.2
Transportation Department	360	5.6	245	4.1	3,165	6.9	4,750	10.0	2,775	11.3
Pipe Lines	275	4.3	175	2.9	2,410	5.3	3,400	7.2	2,100	8.6
Marine	70	1.1	50	0.8	580	1.2	1,000	2.1	500	2.0
Other	15	0.2	20	0.4	175	0.4	350	0.7	175	0.7
Refineries and Chemical Plants	950	14.9	825	13.6	6,175	13.5	8,750	18.5	4,575	18.7
Marketing	475	7.4	450	7.4	3,295	7.2	5,100	10.7	3,200	13.1
Others	90	1.4	55	0.9	615	1.4	700	1.5	450	1.8
Total, All Departments	6,400	100.0	6,050	100.0	45,725	100.0	47,400	100.0	24,500	100.0

* Expenditures include cost of drilling dry holes, but exclude exploration expenses and lease rentals charged to income account. Investment includes only natural gas producing, transmission and distribution facilities of oil companies.

U. S. Oil Investment $58.5 Billion

Investment in refineries and chemical plants totals $8.5 billion or 18.5 percent of total.

GROSS INVESTMENT of the petroleum industry in the U. S. stood at the end of 1957 at a new peak of $58.5 billion. That amount was $4 billion greater than the investment one year previously.

The new total included $47.4 billion in property, plant, and equipment, $10.5 billion in current assets, and $0.6 billion in other assets.

These figures have been reported in the recently issued annual financial analysis of the industry by the Chase Manhattan Bank. The 46 page pamphlet was prepared by Frederick G. Coqueron, Norma J. Anderson, and Richard C. Sparling, of the bank's petroleum department.

Assets by Departments. Of the $47.4 billion of gross investment in property, plant, and equipment at the end of 1957, $27 billion or 57 percent was in crude oil and natural gas production. Gasoline and cycling plants accounted for $1.1 billion, or 2.3 percent. The investment in refineries and chemical plants totaled $8.75 billion or 18.5 percent. That in marketing was $5.1 billion or 10.7 percent.

Transportation facilities involved a gross investment of $4.75 billion, or 10 percent of the industry total. They included $3.4 billion or 7.2 percent

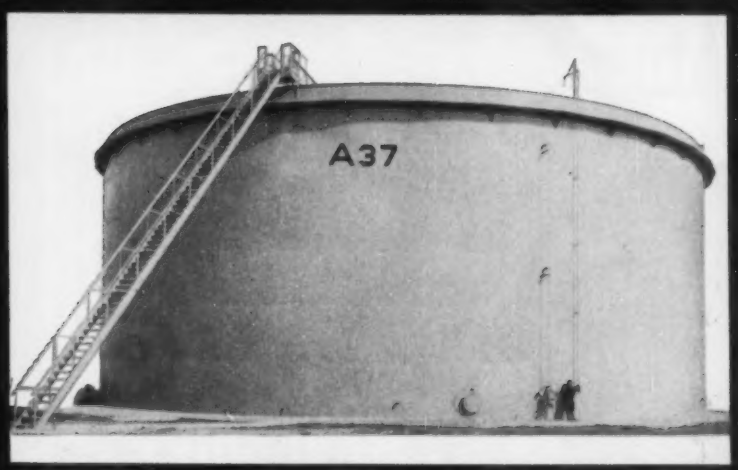
Estimated Assets Employed (or Investment) in U. S. Petroleum Industry December 31, 1957

ITEM	Net Assets		Gross Assets	
	$ Million	% of Total	$ Million	% of Total
Current Assets	10,500	29.5	10,500	17.9
Property, Plant and Equipment	24,500	68.8	47,400	81.0
Other Assets	600	1.7	600	1.1
Total	35,600	100.0	58,500	100.0

Source: Chase Manhattan Bank Bulletin, "Petroleum Industry . . . 1957."

NOOTER

FLOATING ROOF TANKS



Offer You

MAXIMUM

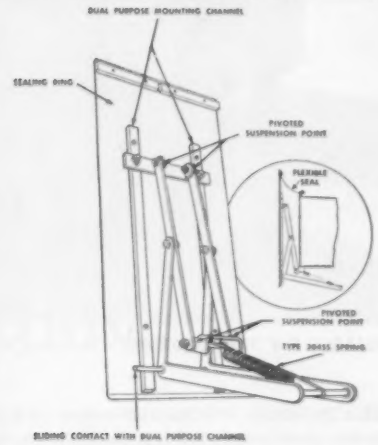
SEAL PROTECTION

MINIMUM

MAINTENANCE

NOOTER is fully experienced in the fabrication and erection of double deck, pontoon and pan type floating roofs—all with the patented Nooter Seal. The Nooter design means better protection for your product because of the more efficient seal . . . minimum maintenance because there is no direct contact with the sealing ring, therefore minimum wear . . . and minimum delay in construction because easier installation and alignment are made possible by the new seal design. These advantages mean a better floating roof tank at a lower cost.

This Patented NOOTER SEAL HANGER is One Reason Why!



This exclusive Nooter 2-Point suspension seal hanger has one pivoted and one sliding point of contact with the dual-purpose mounting channel. This channel serves (1) as a means of attaching seal hanger to shoe without direct contact of seal hanger to shoe, and (2) as a method of providing even distribution of the forces of seal hanger over entire height of shoe.

you can also update your old tanks with the new NOOTER SEAL

The Nooter Seal is readily adaptable to any existing welded or riveted tank. Requires minimum modifications for fast, easy installation.

For your next floating roof tank, or seal replacement, send your inquiries to Nooter. You'll find Nooter quality and dependable deliveries your best equipment investment.

Catalog 158 on Nooter Floating Roof Tanks is yours for the asking.

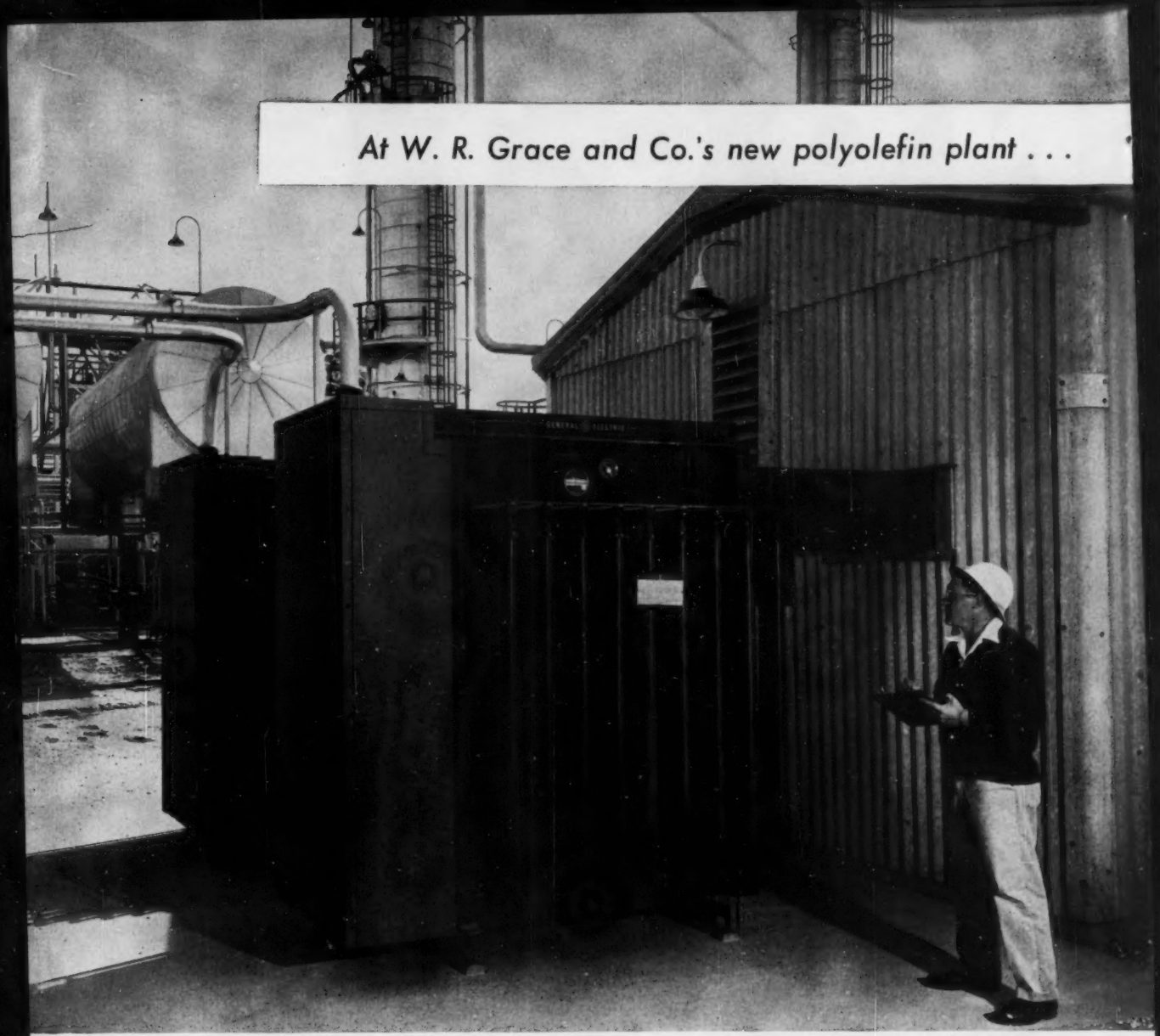
NOOTER CORPORATION

"Since 1896"

Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

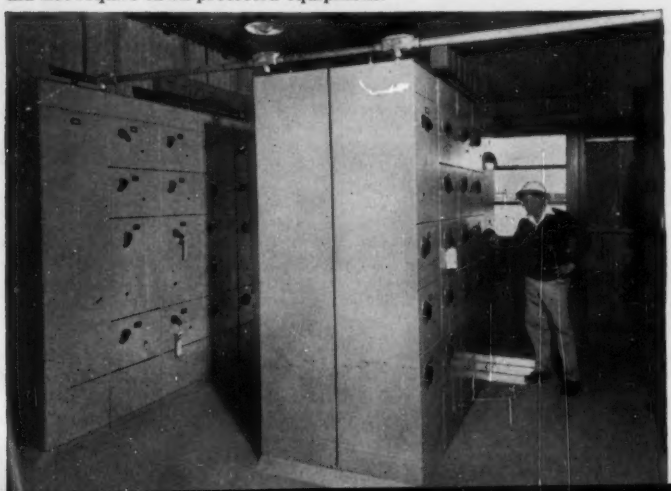
1404 SO. SECOND ST. • ST. LOUIS 4, MO.

At W. R. Grace and Co.'s new polyolefin plant . . .



RELIABLE G-E TRANSFORMERS are easy to install, easy to maintain. Transformers pictured are rated 1,000-KVA.

PRE-ASSEMBLED, PACKAGED nature of General Electric motor-control centers greatly reduced installation costs at new Grace and Co. polyolefin plant. Equipment costs were less because remotely located centers did not require extra-protected equipment.



RELIABLE, LONG LIFE General Electric 150-hp induction motors drive extruders which compress GREX† pellets in their final form.

† Registered Trade-mark of W. R. Grace and Co.

Standardization on General Electric equipment cut spare parts inventory by 60%

OPERATION upturn — Buy now for extra value! — GENERAL ELECTRIC

Here's how single-source purchasing and expert system-engineering assistance cut installation time and costs, and saved valuable floor space for the Polymer Chemicals Division of W. R. Grace and Co.

Because standardization on General Electric motors, controls and switchgear permitted maximum parts interchangeability, W. R. Grace and Co. reduced anticipated spare parts inventories by 60 per cent at their new Baton Rouge polyolefin plant. Now, spare parts for their entire electrical system occupy less than 1 per cent of their warehouse area, making valuable space available for production items.

In addition, G-E engineering know-how and system-engineered electrical products helped cut installation time and costs at this new 50 million pound petrochemical facility

Unit responsibility is the key to these major reductions. Because of the many and varied applications in this plant, W. R. Grace and Co. officials felt that standardization on one supplier was the most efficient and economical way to do the job. Previous experience with G-E equipment and technical assistance encouraged their choice of General Electric.

The pre-assembled, complete-packaged nature of G-E substations, switchgear and motor-control centers greatly reduced installation costs at this W. R. Grace and Co. plant. The remote location of the control equipment—made possible by the principle of the motor-control center—eliminated the need for expensive, specially-protected equipment.

Over 300 rugged G-E induction motors, ranging from fractionals to 150-hp, are spotted throughout the 30-acre site to provide the power required to keep the plant running 24 hours-a-day. These extra-protected motors drive pumps, agitators, extruders, mixers, conveyors and rotary valves. Built for longer life, even under tough refinery conditions, these G-E motors require less maintenance, keep downtime to a minimum.

If you plan to build a new plant, or expand your present facilities, General Electric offers the system-engineered equipment and the technical assistance to provide you with an economical, efficient electrical system. Contact your nearest General Electric Apparatus Sales Office for complete information. General Electric Company, Schenectady 5, New York.

681-16

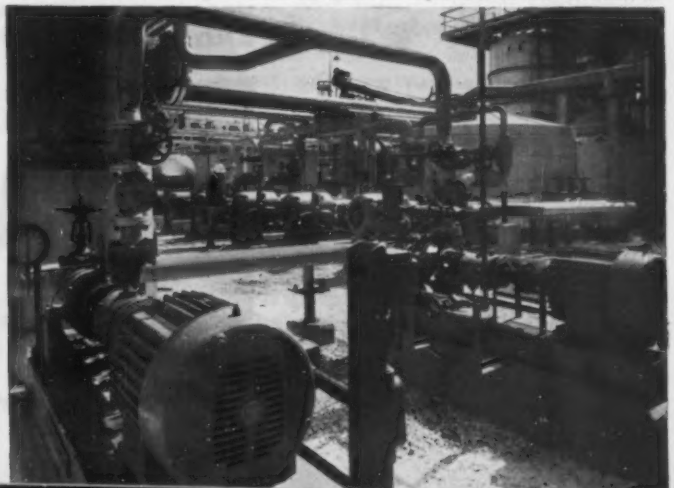
Engineered Electrical Systems for the Petrochemical Industry

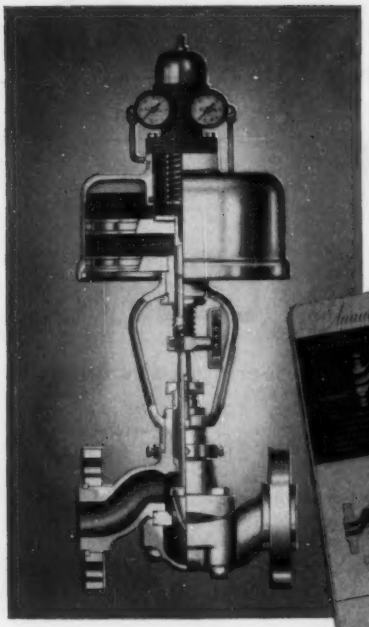
GENERAL ELECTRIC

FOR GREATER MAINTENANCE FLEXIBILITY, G-E AK-25 air circuit breakers can shut off small parts of plant when repairmen are at work. 1200-amp breakers are also used as large motor starters.

RUGGED TOTALLY-ENCLOSED and explosion-proof G-E Tri-Clad* '55' motors provide extra protection and greater safety required for some refinery applications. More reliable Tri-Clad motors require less maintenance, reduce system shutdowns.

*Reg. Trade-mark of General Electric Co.





HOW *ANNIN* DOES IT.

The Best Way Yet in Process Control

SPLIT BODY CONSTRUCTION... SINGLE SEAT DESIGN

No other process control valve offers the advantages in economy and adaptability as that provided by the Annin valve. The split body eliminates pockets and shoulders that create undesirable turbulence and accumulated solids, reduces erosion and allows consistent flow behavior with a wide range of fluids under all conditions.

Superior body design permits conversion in any alloy from the basic Globe Body to Corner, Angle or 3-way construction.

OPERATORS

Three basic Annin operators bring new and improved performance. The DOMOTOR operator is the most responsive, precise positioning and fastest pneumatic operator available... Electro-pneumatic or pneumatic CYLINDER operators, for remote shut-off applications, are designed to withstand continuous "on-off" operations... MANUAL operators, for precise throttling of flow rate and tight closure.

INTERCHANGEABILITY OF COMPONENTS

Applications unlimited are provided by interchangeability of Annin component features. Three types of operators, and five types of packing assemblies (plain extension, bellows seal, doolseal, cooling fin and standard) are interchangeable on one yoke and one body.

SEND FOR THE ANNIN CATALOG—
AN ENCYCLOPEDIA OF VALVE EXPERIENCE AND LEADERSHIP

SIMPLICITY IN DESIGN AND MAINTENANCE

The advantages of Annin single seat, split valve bodies, coupled with the design characteristics of Annin Domotor and other operators, provide control engineers with valves that can be installed without compromise in materials, response, tight closure, piping flexibility and dependability... making possible a reduction of parts from 50% to 75%, lower initial cost, lower spare parts inventory, lower maintenance.

THE ANNIN COMPANY
Division of The Annin Corporation
1040 S. Vail Ave., Montebello, California

ANNIN VALVES

For more data on advertised products, use Readers' Service Cards, last page.

in pipe lines, $1 billion or 2.1 percent in marine properties, and $350 billion or 0.7 percent in other transportation.

Miscellaneous facilities accounted for a gross investment of $700 million or 1.5 percent of the industry total.

Expenditures in 1957. For facilities in the U. S. the petroleum industry in 1957 made capital expenditures totaling $6.4 billion. That was an increase of $350 million over the amount spent in 1956.

The expenditures in 1957 included $4.4 billion or 68.8 percent for crude oil and natural gas production; $125 million or 1.9 percent for gasoline and cycling plants; $950 million or 14.9 percent for refineries and chemical plants; $475 million or 7.4 percent for marketing; $90 million or 1.4 percent for miscellaneous items; and $360 million or 5.6 percent for transportation facilities. The transportation investments included $275 million or 4.3 percent for pipe lines, $70 million or 1.1 percent for marine equipment, and $15 million or 0.2 percent for other transportation items.

Coal Says It Can Meet Middle East Oil Cutoff

The bituminous coal industry "has the reserves and the productive know-how to meet challenges that may arise if Middle East oil is cut off," according to Tom Pickett, executive vice president of the National Coal Association. He added, "if coal is to maintain an expanded production base, it should be assured of a continuing market after an emergency ends rather than again being cast in the role of a standby energy source, like the police and fire departments, to be called into action only when an emergency arises."

Pickett urged Secretary of the Interior Seaton to adopt a long-term fuel policy "that will consistently sustain a healthy coal industry, thus assuring energy supplies for the U. S. and Free World and placing less dependence on vulnerable foreign oil sources."

Armour Research Foundation To Get New ChE Building

A contract has been awarded to an architectural firm to design a multi-million dollar chemistry and chemical engineering building for Armour Research Foundation of Illinois Institute of Technology, Chicago.

The contract was assigned to Schmidt, Garden and Erickson, Chicago. The proposed 125,000 square-foot building is the third in a ten year expansion program announced two years ago.

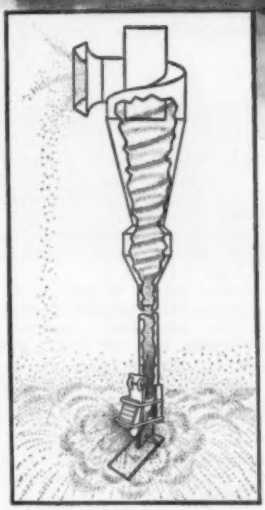
Asphalt Sales Drop Off

Sales of asphalt and asphaltic products were 5 percent lower in 1957, compared with a gain of ten percent in 1956, according to a Bureau of Mines survey.

Paving asphalt showed a two percent decline. However, according to the Bureau of Public Roads, demand for asphalt for maintenance and construction of public

Positive Dip-Leg Seal with Catalyst Density Increased 50% or More...

DUCON TRICKLE VALVES



PATENTS PENDING

Ducon Trickle Valves provide greater stability of cyclone operation by minimizing start-up and upset catalyst losses. Increased dip-leg seal catalyst density permits greater thru-put without additional dip-leg length and vessel height. With hundreds of Ducon Trickle Valves in service, the petroleum refinery industry itself has proved their unsurpassed dependability for continuous, trouble-free operation.

Write for details now on Ducon Type CA Trickle Valves—**the first dip-leg seals with approval for fluid catalytic cracking plants.**

Ask for Descriptive Bulletin No. CV-2506

DUCON

the name in DUst CONtrol

THE Ducon COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

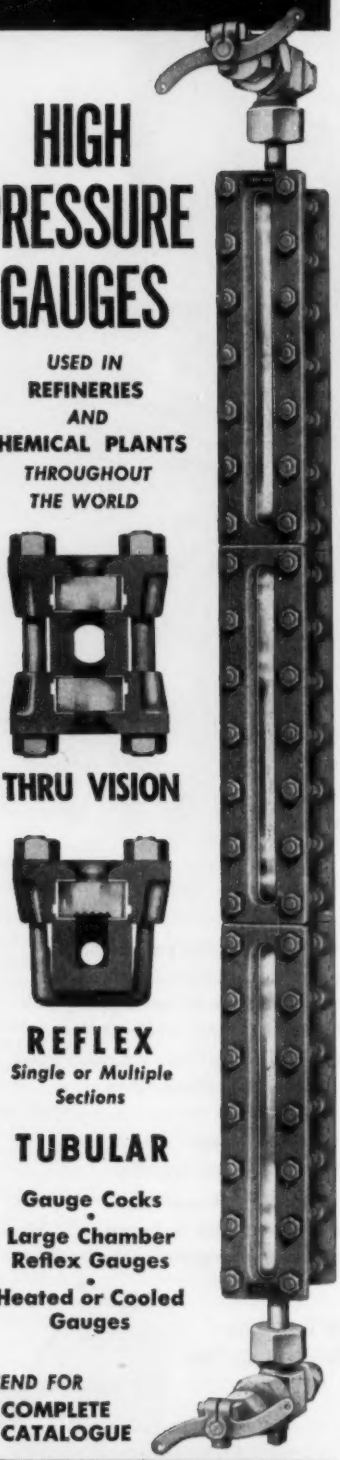
CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

For more data on advertised products, use Readers' Service Cards, last page.

Strahman

HIGH PRESSURE GAUGES

USED IN
REFINERIES
AND
CHEMICAL PLANTS
THROUGHOUT THE WORLD



THRU VISION

REFLEX
Single or Multiple Sections

TUBULAR

Gauge Cocks
•
Large Chamber Reflex Gauges
•
Heated or Cooled Gauges

SEND FOR
COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
16 Hudson St., New York 13, U.S.A.

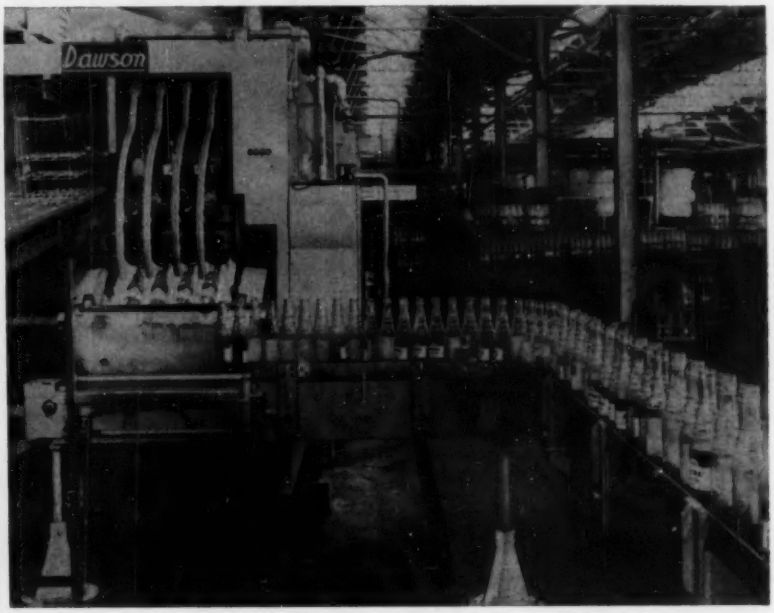
What's Happening . . .

highways showed an increase in 1957 over 1956.

Asphalt delivered for paving purposes amounted to 73 percent of all sales in 1957 compared with a 71 percent share in 1956. Quantity sold for roofing materials dropped from 20 percent of the total in 1956 to 17 percent in 1957, while that for the manufacture of miscellaneous products was nine percent of the total and ten percent in 1957.

New building construction declined again in 1957, as it did in 1956. Total asphalt sold for roofing products was lower by 17 percent in 1957, compared with a three percent decline in 1956.

Asphalt sold for the manufacture of miscellaneous products declined by one percent in contrast to a 16 percent gain in 1956.



Esso Petroleum Company, Ltd., recently installed this new automatic bottling plant for motor oils at their Purfleet, Essex Terminal. Designed by Dawson Bros. Ltd., of Gomersal, England, the installation includes bottle and crate conveyor lines, a bottle and crate washing and drying machine, a filling machine and a sealing machine.

Gas Industry Construction Booming

The gas industry's construction expenditures reached an all-time high of more than $1.77 billion during 1957, and new forecasts indicate the industry will top that record this year by spending nearly $1.87 billion for expansion of gas facilities throughout the U. S.

In its annual survey of gas utility and pipeline construction expenditures, the American Gas Association reported that last year's record high of $1,772 million in construction outlays represents a 14.2 percent increase over the $1,552 million spent in 1956.

The Association now estimates that construction expenditures this year will set a new record of $1,868 million, while next year's expansion programs will total about $1,736 million.

During the two-year period which includes 1958 and 1959, total anticipated construction expenditures of $3.6 billion will be 8.4 percent above the previous two-year high of $3.3 billion, established in 1956-57. More than 96 percent of the construction funds will be used for the expansion of natural gas facilities.

The extension of transmission systems accounted for the largest single share of last year's construction expenditures, with such expenditures amounting to $753 million during the 12-month period. Transmission construction outlays are expected to rise to $918 million this year and will be $693 million in 1959.

Expenditures for distribution facilities construction, which have shown a steady increase in recent years, totaled $593 million in 1957. This figure represents an 11.1 percent gain over the $534 million spent the previous year.

A.G.A. estimates that construction of distribution facilities will aggregate $575 million in 1958 and will climb to a new high of $682 million in 1959. Expansion of distribution plants and facilities is expected to cost $624 million in 1960 and $610 million in 1961.

A.G.A. reports that gas industry expenditures for the construction of production and storage facilities also reached an all-time high of $350 million last year. Outlays will total $289 million this year and $280 million in 1959.

The industry now has a network of mains extending nearly 549,000 miles, including 23,600 miles added during 1957. Local utility companies increased their distribution systems by 14,900 miles last year, while transmission systems grew by 6,300 miles. Field and gathering networks operated by gas utility and pipeline com-

For more data on advertised products, use Readers' Service Cards, last page.

THIS MAN'S A SPECIALIST IN PROTECTING YOUR PROFITS. His title is Dowell Service Engineer. His job—to study your maintenance cleaning problems, recommend the proper solutions and apply chemical solvents to help you make more profit. He represents a team of specialists who have rendered old-fashioned all other methods of cleaning product, process and steam generating equipment. His method is Dowell Service, the modern way—using solvents—to remove scale and sludge from all kinds of metal equipment, tanks, piping and lines.

Specifically: one processor had been performing his own turnaround service—using mechanical methods—at an annual cost of $315,000. The Dowell Service Engineer and his team performed the same service in 1/10 of the time at a cost of $2300. The savings in downtime alone amounted to $210,000.

If your maintenance and operating engineers do not know the profit possibilities with Dowell Service, ask them to get the facts for you. For specific information on how chemical cleaning can help your plant to greater profits, call the Dowell office nearest you. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma, with 165 offices and stations to serve you.

chemical cleaning services for industry DOWELL

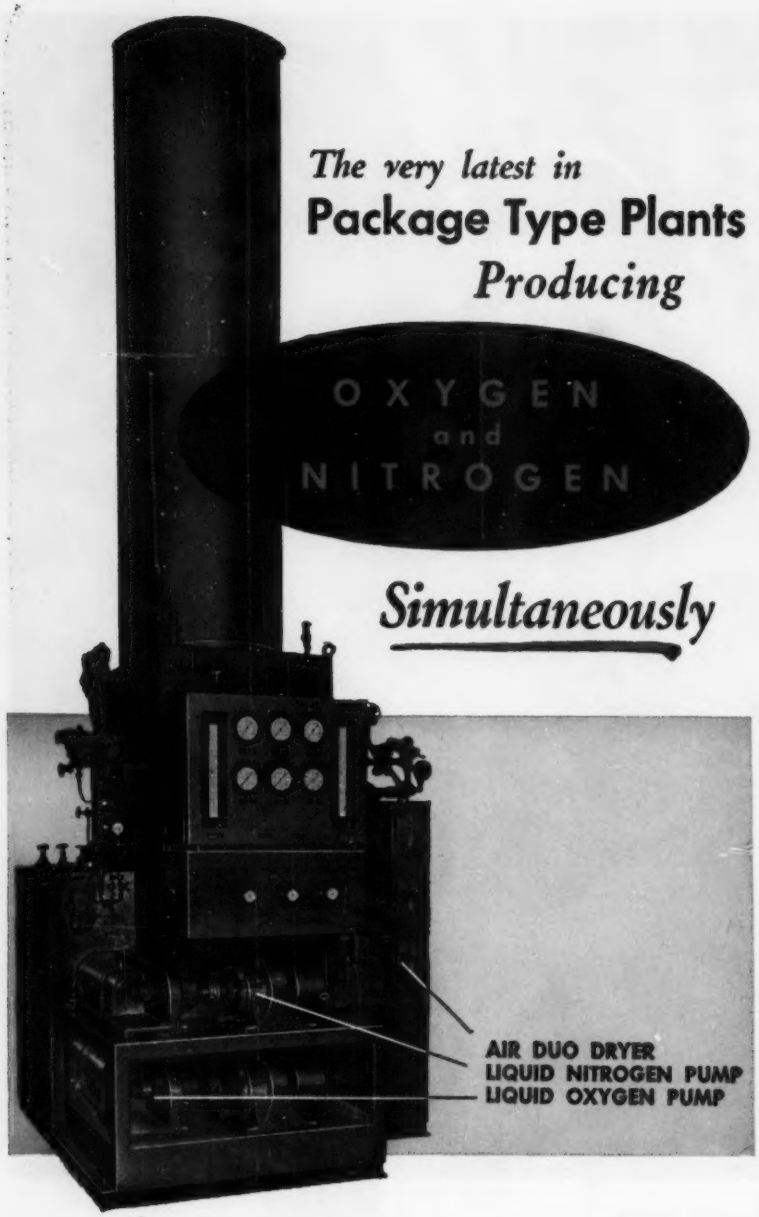
The very latest in

Package Type Plants

Producing

OXYGEN and NITROGEN

Simultaneously



With the introduction of our latest, improved design Package Type Generating Plants, production of high purity Oxygen and Nitrogen simultaneously *increases* production 60% over the production of Oxygen alone, *plus* a corresponding reduction in the *cost* of manufacture. Due to its compact design, a minimum of floor space is required and streamlined panel assembly insures instant visibility of all control gauges. Stock sizes from 1500 to 10,000 cu. ft. per hour. Larger and smaller sizes available. 99.99% Argon available on large size plants.

We invite your inquiry.

INDEPENDENT ENGINEERING COMPANY, Inc.

Manufacturers of

CONSULTING IECO DESIGNING

CYLINDERS AND GAS PRODUCING EQUIPMENT
ACETYLENE - OXYGEN - NITROGEN - ARGON

What's Happening . . .

panies increased by 2,400 miles during the year.

The total utility plant of the gas industry rose to a new peak of $16.69 billion at the end of 1957, up 11.8 percent from the previous year's level of $14.93 billion. By the end of last year, the industry's total assets had increased to a record high of $19.76 billion.

Noting that 1957 construction expenditures did not reach earlier forecasts, the gas association attributed the reductions to the impact of regulatory and judicial factors. Delays in granting certificates of convenience and necessity, regulatory confusion caused by the Phillips and Memphis decisions, and the modest effect of the general business recession all combined to curtail last year's gas industry building and development programs.

The Memphis decision last November also affected A.G.A. forecasts of future construction spending. The Association's new survey report includes two-year projections of transmission construction expenditures instead of the four-year estimates presented in previous annual studies. A.G.A. explains that the U. S. Court of Appeals decision in the Memphis Case has created uncertainty in the gas industry, particularly among pipeline companies. This has led many large transmission companies to limit their own forecasts of future construction expenditures to 1958 and 1959, said the Association.

Soviet Technical Data to Be Offered by Government

Translations of Russian technical publications in petroleum and natural gas fields will begin on a large scale soon by the government and be made available to U. S. industry.

The Commerce Department has been handed $500,000 by Congress to establish a clearing house for government-translated Soviet technical information.

OTS will, at first, publish a list of material already on hand. Beginning in September, it will offer subscriptions to some 141 Russian technical journals that will be abstracted and translated on a regular basis.

OTS wanted $1 million to handle the job, of which Congress granted half. But the operation will likely be expanded if successful. Further information may be obtained from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

Shift to Oil-Gas Use By Government Attacked

The United Mine Workers and the National Coal Association are making an effort to block the governments policy of shifting from coal to oil and gas for heating government installations, according to Congresswoman Kee (D-W. Va.). She said the switch is being made "without substantiated studies to prove that other fuels are more economical than coal." The change is the latest "in a growing number of conversions which damage the coal industry," she added.

The protest arose from substitution of oil for coal at the Army's Ft. Eustis, Va.

Mrs. Kee said in a press release that

For more data on advertised products, use Readers' Service Cards, last page.

"the Army has agreed to permit NCA heating experts to make a study in Ft. Eustis, in order to develop facts which will prove that coal is the most economical fuel to use in these plants."

Meanwhile, the National Coal Association charged that conversion of government boiler rooms from coal to other fuels is based on exaggerated cost figures and "just is not good sense."

Tom Pickett, NCA vice president, said the coal industry "observes a widespread and apparently coordinated movement to convert coal-fired boiler rooms under government control to oil or natural gas. To justify such a change, completely unrealistic figures often are submitted for labor, maintenance, and other costs of operating coal-fired boilers. These figures are frequently far out of line with the experience of private industry. If the governments figures are accurate, there is appaling inefficiency and waste of manpower in the operation of government boiler rooms. The cure is not in another fuel, but in better operating procedures and effective supervision."

Southern coal producers have charged that U. S. foreign policy is ignoring economic distress in the coal industry and favoring oil interests. The charge was made to Deputy Undersecretary of State C. Douglas Dillon by Joseph E. Moody, president of the Southern Coal Producers Association. Moody said "the State Department's lax attitude where this country's basic and most plentiful fuel is concerned, does not end here. In the case of residual oil, which is dumped at East Coast ports, imports now displace more than 41 million tons of coal annually. These imports are being dumped by a cartel which has been charged by the Justice Department with conspiracy to violate the anti-trust laws. The case still is pending after five years."

Moody added that "from all indications, the State Department has been extremely solicitous of the welfare of our oil industry. It would be helpful indeed if the Department would review its coal policies in the light of these representations."

Gas Still Ahead of Oil And Coal as Power Supply

Natural gas is still holding the edge over fuel oil and coal in supplying electric power plants, according to the latest report from the Federal Power Commission. The FPC said fuel oil consumption dropped 8.9 percent to 72 million barrels for the year ending June 30. Coal was off 2.8 percent to 156 million tons, while gas consumption for the year climbed 6.4 percent to 1,354,578,685 Mcf.

The report also revealed that consumption of coal by power plants during the first six months of 1958 reached 76 million tons, a decrease of 5.8 percent from the first half of 1957.

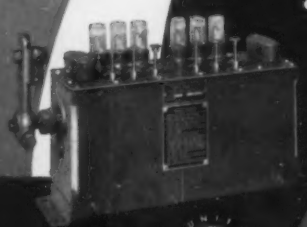
Coal use during June was 11½ million tons, a decrease of 8.8 percent from the 12½ million tons burned in June, 1957, but 1.4 percent above the 11.24 million tons consumed in May.

June fuel oil consumption reached 5.34 million barrels, 14.3 percent below the 6.23 million barrels burned in June, 1957, but 11.7 percent above May consumption. Oil consumption of 34.79 million barrels during the first six months of 1958 was 18.1

MANZEL

dependable
accurate
lubrication

GET FULL VALUE for your lubrication dollar, with a Manzel Force Feed Lubricator. Exclusive Vacuum Pumping Unit with "dry sight feed" solves liquid sight feed problems, increases accuracy, cuts lubricator maintenance. Interchangeable with liquid sight feeds on existing Manzel lubricators. Get full details from your Manzel field engineer.



WRITE FOR COMPLETE CATALOG giving specifications and performance requirements to meet any of your lubricator needs.

HOUDAILLE

Manzel

285 Babcock Street • Buffalo 10, New York

Specialists in metering pumps and lubricators since 1898

For more data on advertised products, use Readers' Service Cards, last page.

In *critical* processing at SUN OIL... it's SELAS Gradiation®

SUNOCO

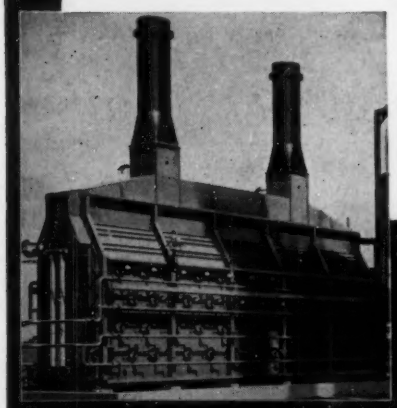
Take catalytic reforming. Rapid, precise heating is of utmost importance in this critical petroleum process. Where a 5°F variation in outlet temperature can adversely affect product octane by as much as one number, the value of Gradiation heating—providing ±1°F control—is obvious.

Selas Gradiation heaters are in service in most of the major catalytic reforming processes: in visbreaking, light hydrocarbon pyrolysis, in high temperature heating including cylindrical reactors.

In critical processing operations in the petroleum and petrochemical industries, Selas Gradiation heating provides

- Preciseness of heating
- Ability to handle a variety of feed stocks; for example: ethane, propane, ethane-propane mixtures including propylene—in one heater
- Instant response to controller demand, achieving close equilibrium approach
- Zone Control . . . up to 3 independent coils in the same heater

Specially-engineered and custom-built to meet your specific processing needs, Gradiation tubular heaters are available both Selas-shop-assembled and field-erected.



Selas multiple-coil Gradiation heater in Houdriformer service, producing high octane gasoline at Sun Oil Company, Ltd., Sarnia, Ontario, refinery.

SUBSIDIARIES: Selas Constructors, Inc., Houston, Texas; Selas Corporation of America, European Div., S. A., Pregny, Geneva, Switzerland. **INTERNATIONAL REPRESENTATIVES AND LICENSEES:** CAMBODIA, FORMOSA, KOREA, LAOS, VIETNAM—Cosa Export Co., Inc.; JAPAN—International Machine Co., Ltd., Tokyo; COLOMBIA, VENEZUELA—Intertec, C.A., Caracas; GERMANY—Ernst Kirchner, Hamburg; ITALY—Societa Italiana E. Kirchner, S.r.l., Milano; FRANCE—Societe Exploitation de Produits Industriels, Paris; BENELUX, PORTUGAL, SPAIN—Union Chimique, Brussels.

is your reward

In *non-critical* processing at CALIFORNIA OIL . . . it's SELAS Econotherm*

Where operations require materials to be heated below decomposition temperatures; where, because of this condition, precise control is not required; where, by the very nature of the operation, low first cost is an important factor . . . Selas Econotherm heaters are the choice of California Oil and other processors in the petroleum industry.

Depending on the desire of the customer, and the economy involved, Econotherm heaters may be delivered intact to the job-site—completely Selas-shop-assembled, or field-erected, as in the case of this California Oil installation.

Three basic Econotherm designs have been developed to achieve maximum economy. To meet processing conditions not covered by these standard units, specially-designed Econotherm heaters will be custom-built as required.

• • •

Send for Bulletin 79 "Gradiation Heating for Petroleum and Chemical Processing." Selas engineers will be glad to discuss your heat-processing requirements with you.

Multiple-coil, floor-fired (using combination gas and oil burners) Econotherm crude unit heater in vacuum service at the California Oil Co., Perth Amboy, N. J., refinery.

Gradiation is a registered trade name of Selas Corporation of America.

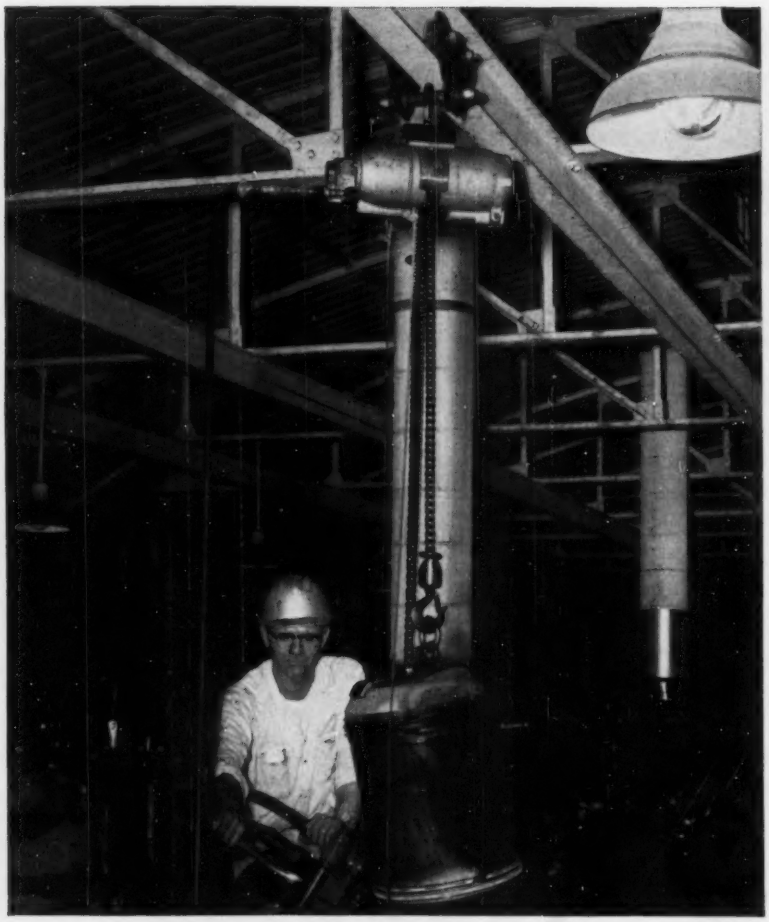
*Trade Name

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

For more data on advertised products, use Readers' Service Cards, last page.



Air-powered pickup for refinery maintenance

Lift . . . lower . . . and hold heavy loads safely with an air-powered hoist package from the Gardner-Denver line. Gardner-Denver air hoists give you:

- **Operator safety**—powerful brake holds load regardless of air supply. One-hand control leaves a hand free to guide load.
- **Spark-free power**—won't spark or burn out. Safe for use in any atmosphere.
- **Variable-speed control**—responds instantly to finger-tip command. Speed governed by air supply.
- **Economical operation**—use air efficiently . . . require little maintenance
- Seven models to choose from . . .

Model No.	Capacity	Max. Full Load Speed	Weight of Hoist
86-2V40	4000 lb.	10 fpm.	100 lb.
86-2V20	2000 lb.	19 fpm.	90 lb.
86-2V10	1000 lb.	38 fpm.	90 lb.
86-1V10	1000 lb.	19 fpm.	40 lb.
86-1V5A	500 lb.	38 fpm.	40 lb.
86-1V3	300 lb.	80 fpm.	40 lb.
86-A1	150 lb.	40 fpm.	14 lb.

Write for Bulletin 86

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

What's Happening. . .

percent below the like period in 1957.

Gas consumption in June amounted to 138,636,665 Mcf, an increase of 10 percent from that burned in June, 1957, and 18.1 percent above that burned in May. Gas consumption for the first half of 1958 was 600,849,865 Mcf, an increase of 2.8 percent from the 1957 period.

Fuel stocks on hand as of July 1 totaled 20.4 billion barrels, compared with 20.8 billion barrels a month earlier and 18.8 million barrels a year earlier.

The report may be obtained from the Federal Power Commission, Washington 25, D. C. for $.10.

Program for Annual Meeting Of S. Texas AIChE Ready

Management and technical problems are due for close scrutiny at the Annual Technical Meeting of the South Texas Section of American Institute of Chemical Engineers to be held in the Moody Center Building, Galveston, Texas, October 3, 1958.

In addition to the general session, symposiums and panels have been scheduled on the following timely topics: "Management and an Individual's Education, Advancement, and Future"; "Modern Computation Methods"; and "Use of Statistics in Research and Production." Dr. J. J. McKetta, University of Texas, will moderate a group discussion on "Professionalism—What Does It Mean" and Dean W. W. Hagerty, also from the University of Texas, will lead a similar discussion on "Present Trends and Planning for the Future in Engineering Curricula."

More than 50 exhibits will be set up in the Moody Center, displaying the latest equipment for both plant and laboratory. The registration desk opens at 8:00 A.M. and technical sessions begin at 9:30 A.M. General Chairman for this Thirteenth Annual Meeting is K. S. McMahon, Wyatt C. Hendrick Engineering Corp., Houston, Texas.

River States Oil Company Buys Northeast Company

River States Oil Co., Evanston, Ill., has acquired Northeast Oil Co. of Minneapolis.

Northeast Oil, a marketer of refined petroleum products, owns and operates service stations in the Twin Cities area. Its assets were acquired from Waldro Carpenter, owner.

River States Oil is a marketer which wholesales and retails finished petroleum products, in Minnesota, Illinois, Iowa, and Wisconsin.

Plans Made for Merger Of OCAW and ICWU

The way is open for the eventual merger of the Oil, Chemical & Atomic Workers union and the International Chemical Workers Union. Delegations of the two unions opened their books and disclosed their organizational and financial structures "down to the last penny" at a meeting in Cleveland, August 14-15, according to a spokesman.

Union chiefs said, "we have agreed on a detailed program which will provide a definite timetable of preparations for the merger of our two unions." ICWU spokes-

For more data on advertised products, use Readers' Service Cards, last page.

to all interested in
better refractory linings . . .

A SPECIAL ANNOUNCEMENT of TWO NEW PLIBRICO PRODUCTS

PLICAST GUNLITE
. . . for one shot regenerator linings

PLI-TAB TROWEL MIX
. . . for transfer lines, cyclones, valve bodies, etc.

Here are two refractories developed especially for refinery applications and just released into production after being tested and approved by one of your industry's own members.*

PLICAST GUNLITE, as test results prove, embodies all the desirable characteristics . . . strength, abrasion resistance, and service temperature range . . . for an effective one shot pneumatically placed catalyst regenerator lining that speeds up installation, reduces down time. Requires 95 lbs., including rebound, to place 1 cu. ft.

PLI-TAB TROWEL MIX is a tabular alumina material that's exceptionally and uniformly abrasion resistant at all temperatures up to its service limit of 2000 deg. And it's chemically resistant to a variety of acid and basic conditions. Requires only water additive. Sets in 2 to 4 hours, cures in 12. Has a density of 150 lbs./cu. ft. Its strength and abrasion resistance make it the perfect lining material for catalyst collector cyclones, pick-up points, elbows, valve bodies, transfer lines, etc.

May we give you full data on these effective new refractories.

*Name upon request

Plibrico REFRACTORIES ENGINEERING CONSTRUCTION

PLIBRICO COMPANY • CHICAGO 14, ILL.
Plibrico Sales & Service in Principal Cities
Plants in Canada • England
Holland • Germany • Japan

New

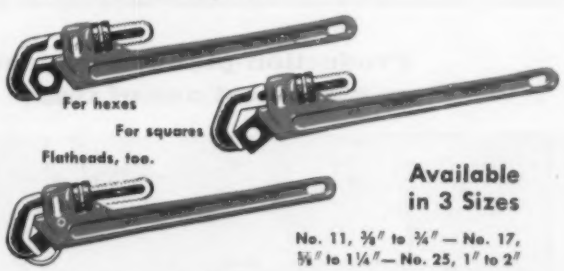
Pat. Applied For

RIDGID

Hex Wrench

gives you Time-Saving, Positive, 4-Sided Grip on Hex Nuts, Square Nuts, Valve Packing Nuts, Unions, Gas Cocks

Here's the adjustable wrench you've always needed for hexes, squares and flatheads, rough or finished. Extra useful on every job. No more barked knuckles or rounded nut shoulders. New wide-open jaw goes on easy . . . won't slip off. 4-sided grip gives extra leverage. Stays to adjusted size during use.



Available in 3 Sizes

No. 11, 3/8" to 3/4" — No. 17, 1/2" to 1 1/4" — No. 25, 1" to 2"

Famous RIDGID heavy-duty construction with guaranteed housing. Narrow jaw design makes work easy in tight places even on thin nuts. Comfort-grip I-beam handle has handy hang-up hole. The new RIDGID Hex Wrench gives you more for your money than wrenches costing twice as much. Try it, buy it at your Wholesaler's.

The Ridge Tool Company • Elyria, Ohio, U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.

Looking for cost leaks? Look at your steam traps

Engineering approach to steam trapping can save thousands a year on costs of fuel, trap maintenance, process cycle time, and uniformity of product quality

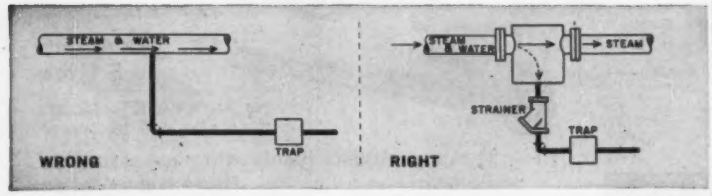
Plant and process engineers all across industry have found that Sarco *Production-Planned* steam trapping can pare operating costs by thousands of dollars a year.

Production-Planned steam trapping is an engineering approach to the problem of getting full design values of heat transfer from steam using equipment. Scores of case histories show that it can make substantial savings and improve processing efficiency. At the same time, costly trap maintenance can be greatly reduced.

In Sarco *Production-Planned* steam trapping, traps are matched to the job by *type* as well as size. They are properly placed, correctly installed. And, to keep down maintenance and replacement costs, every trap is top-quality.

It may pay you well to take this engineer's-eye view of *your* steam trapping. And why not have a Sarco representative look over your system with you? His suggestions will be completely objective because Sarco—and only Sarco—makes a steam trap for every basic requirement. Quality? Recognized everywhere for half a century.

Production-planned systems make best use of traps



As the two illustrations above show, correct application of steam traps is as necessary as using the right trap. In the hook-up on the left, the lack of a condensate collection point plus the long leg to the trap will result in condensate's flowing past the drain point, possibly causing water hammer. The correct way to install the trap is shown at right, placed close to the drain point. A *strainer* should be placed before *any* trap to prevent entrance of scale or other foreign matter into the trap.

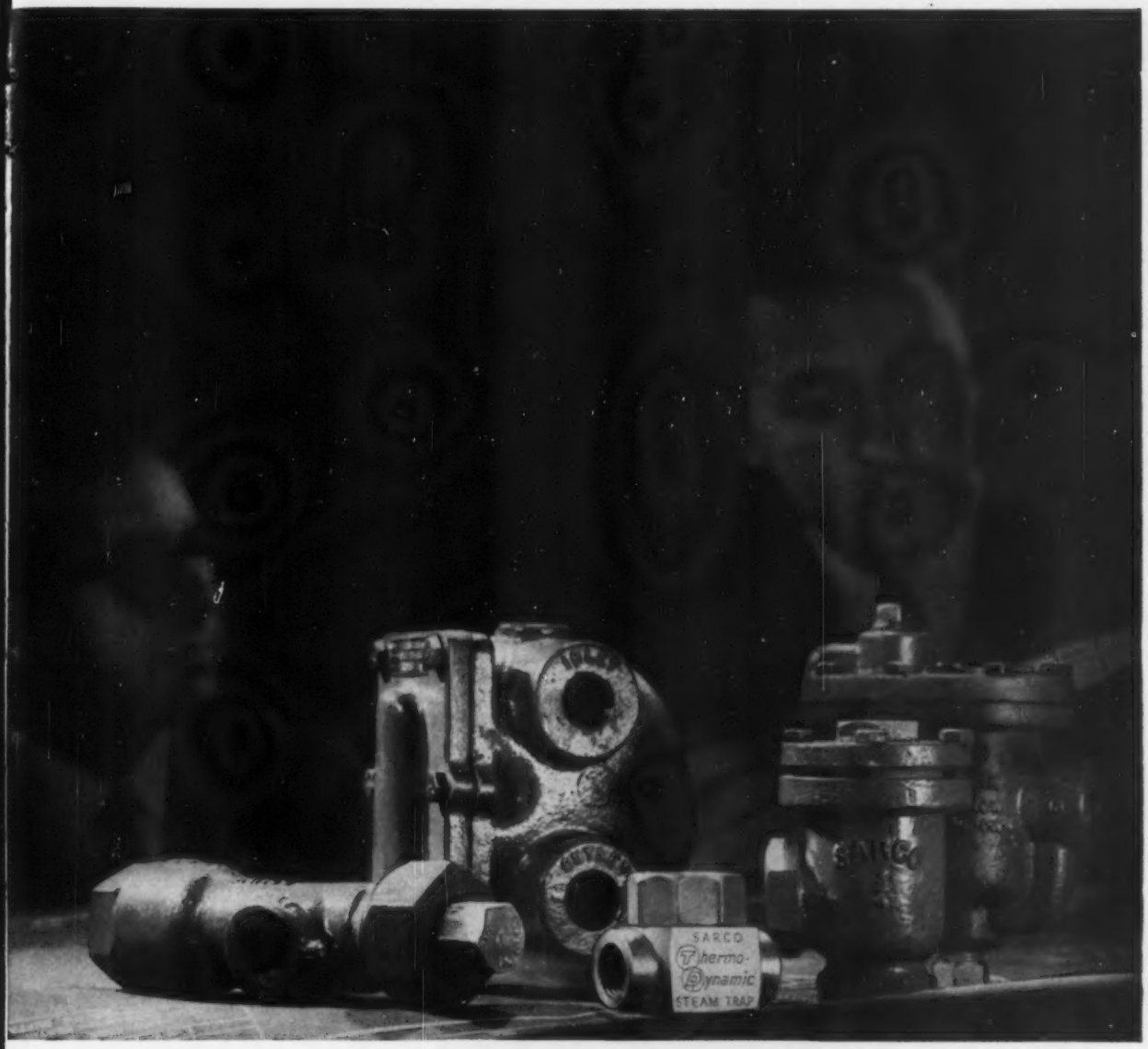
This is just one example of the way your Sarco representative can help you plan your steam system for maximum production.

Traps must be matched to job for best system performance

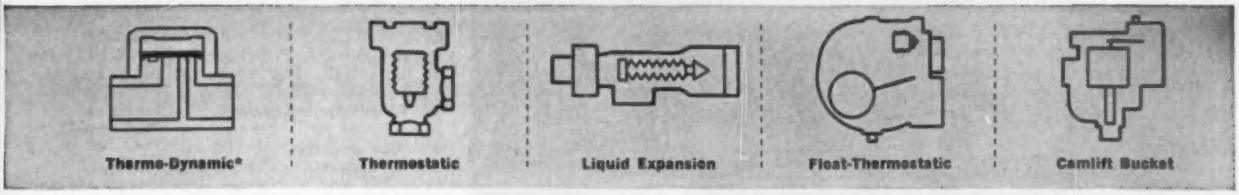
No single type of steam trap will perform well in all applications. Each type has a range of applications for which it is best suited. For optimum efficiency these differences must be taken into account; traps must be chosen for their operating principles as well as their size and pressure rating.

Sarco can give you impartial help in selecting traps because only Sarco makes the five basic types. With Sarco, it's simple —one source, one responsibility, for all your trapping needs.

For more data on advertised products, use Readers' Service Cards, last page.



Only Sarco makes these five basic types of steam traps



5579

Take these two steps to Production-Planned steam trapping:

(1) Write today for Sarco literature; (2) Talk with your Sarco representative. He can help you check your trapping requirements, and he has—or will quickly get—the right answer to any unusual trapping problem.

*T.M.U. Pat. No. 2,817,353.

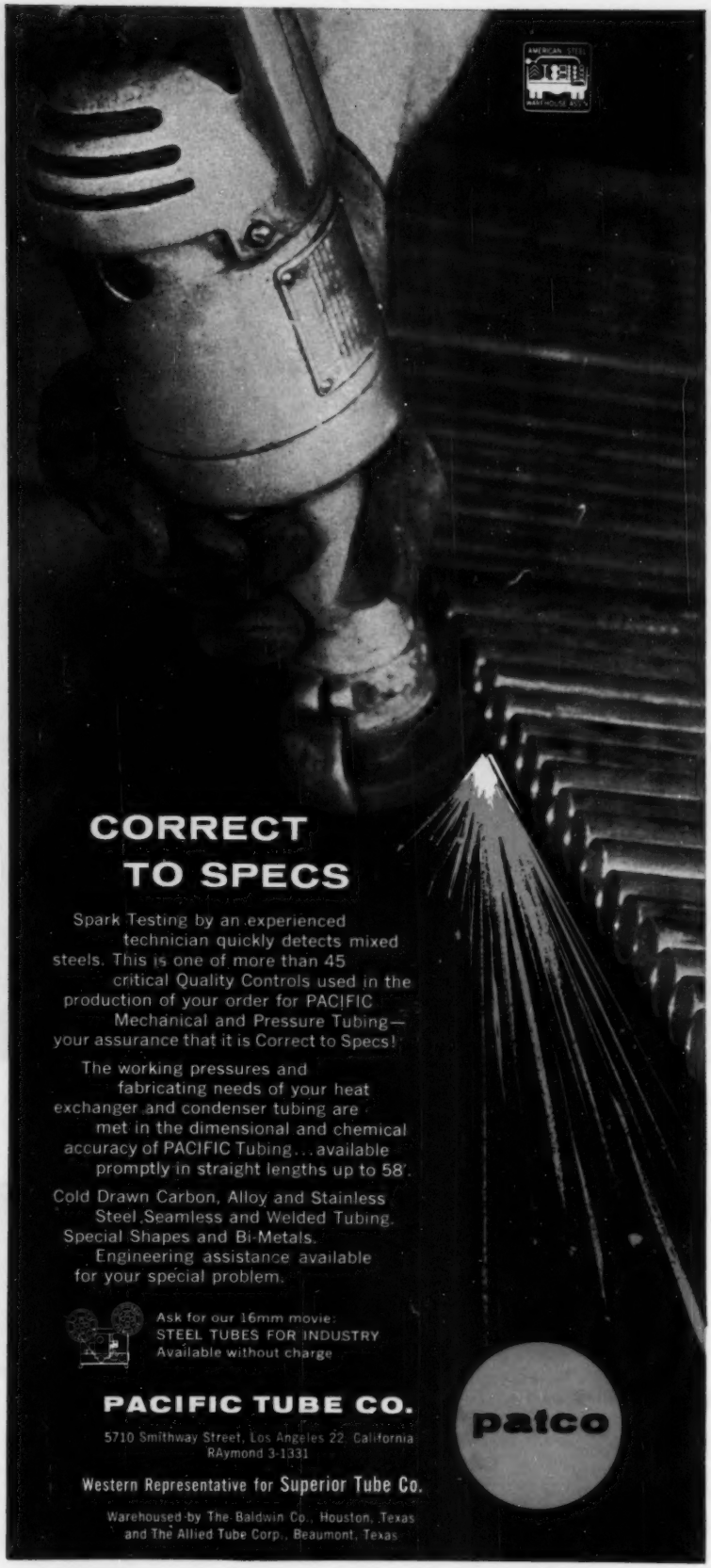
SARCO

COMPANY, INC.

635 Madison Ave., New York 22, N. Y.

STEAM TRAPPING • AIR VENTING • TEMPERATURE CONTROLS • HEATING SPECIALTIES

For more data on advertised products, use Readers' Service Cards, last page.


CORRECT
TO SPECS
Spark Testing by an experienced technician quickly detects mixed steels. This is one of more than 45 critical Quality Controls used in the production of your order for PACIFIC Mechanical and Pressure Tubing—your assurance that it is Correct to Specs!
The working pressures and fabricating needs of your heat exchanger and condenser tubing are met in the dimensional and chemical accuracy of PACIFIC Tubing... available promptly in straight lengths up to 58'.
Cold Drawn Carbon, Alloy and Stainless Steel Seamless and Welded Tubing. Special Shapes and Bi-Metals. Engineering assistance available for your special problem.
Ask for our 16mm movie: STEEL TUBES FOR INDUSTRY Available without charge
PACIFIC TUBE CO.
5710 Smithway Street, Los Angeles 22, California RAymond 3-1331
Western Representative for Superior Tube Co.
Warehoused by The Baldwin Co., Houston, Texas and The Allied Tube Corp., Beaumont, Texas
patco

What's Happening...

men said the merger timetable would be submitted soon to the executive board in Louisville. If the board approves, the plan will go before the international convention in Washington, October 6. OCAW's international convention is scheduled for the third week in this month.

OCAW chiefs plan to call for an increase of $1.00 per month in per capita dues, bringing OCAW's per capita tax to $2.50, compared to $1.50 for ICWU.

Bureau of Mines Shows Use of Liquid Gas

The nation's production of natural gas liquids averaged 31.3 million gallons in May, eight percent less than a year earlier, according to the Bureau of Mines.

Refinery-produced liquefied gases were reported to average 6.5 million gallons daily, a three percent boost. The demand for liquefied gases for fuel and chemical uses in May was two percent higher than in May, 1957. Stocks of liquefied gases totaled 623 million gallons, down 178 million gallons from a year ago.

The daily average demand for natural gasoline in May was 11.3 million gallons, a decrease of six percent from April, 1958. Stocks of natural gasoline totaled 153 million gallons, an increase of six million gallons from a year earlier.

Underground stocks for May totaled 445 million gallons, an increase of 141 million gallons.

Esso's Employe Investment Up to 69 Percent in 5 Years

Esso Standard Oil Co.'s average investment per employe in plant and equipment has increased 69 percent in the last five years—from $26,000 to $45,500.

Esso's President William Naden said capital investments by industry are "the most important single factor in the productivity increases which bring great benefits to the economy as a whole." He added that "such investments are often minimized or ignored when productivity increases are measured and evaluated. He said that in Esso's case, "most capital expenditures were used to improve quality, service and efficiency, rather than to boost capacity."

E. P. Schoch Lectures Slated

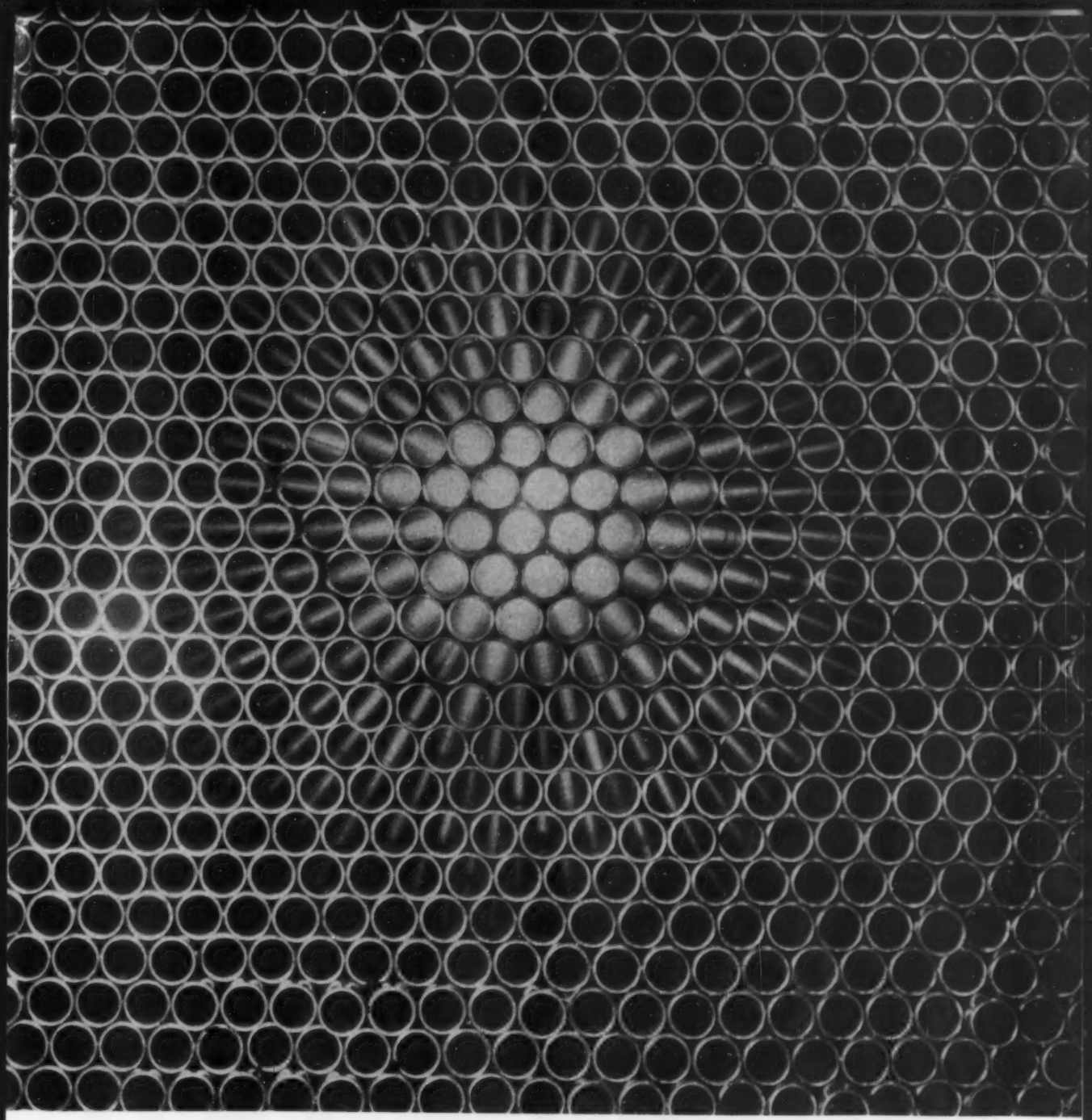
Dr. Richard H. Wilhelm, chairman of Chemical Engineering department of Princeton University, will be the Lecturer for the Third E. P. Schoch Lecture Series at Batts Hall, The University of Texas. Professional Progress Award Winner of the AIChE and a national director of the AIChE, he will lecture on "Reaction Kinetics and Reactor Design."

The Lectures will be held October 17 at 2 PM and 8 PM and October 18 at 10 AM. There will be no admission charge and anyone interested in Reaction Kinetics and Reactor Design is invited.

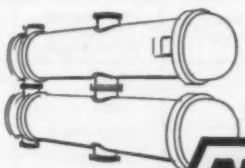
Wide Range of Subjects to Be Covered at AIChE Meet

More than 80 technical papers covering topics ranging from petroleum substitutes to chemical engineering in nuclear appli-

For more data on advertised products, use Readers' Service Cards, last page.



READY TO BUNDLE into heat exchangers for chemical and petroleum service, tubes and other standard components are kept fully stocked for assembly-line production at Kellogg's fabricating shops in Jersey City. Whatever your requirements, Kellogg assures strict conformance to the highest engineering and fabricating standards. For prompt deliveries plus engineering excellence at optimum cost, call Kellogg's Fabricated Products Division.

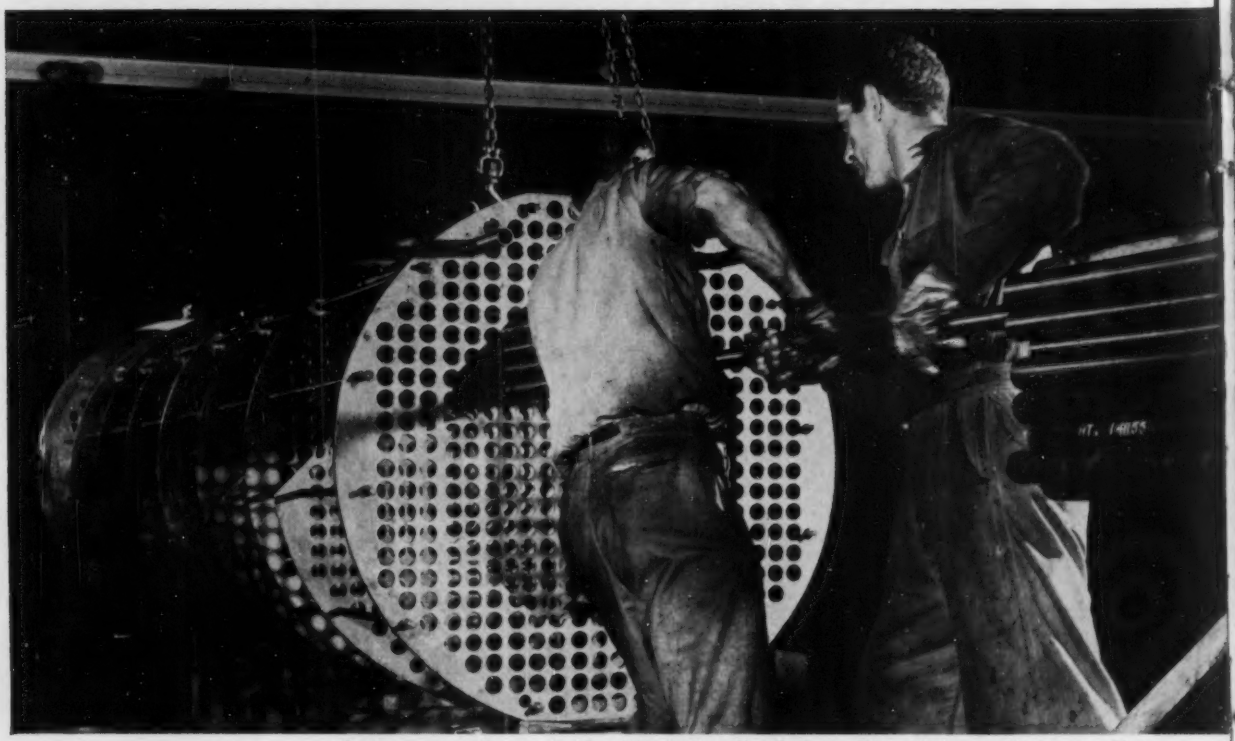


THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N.Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

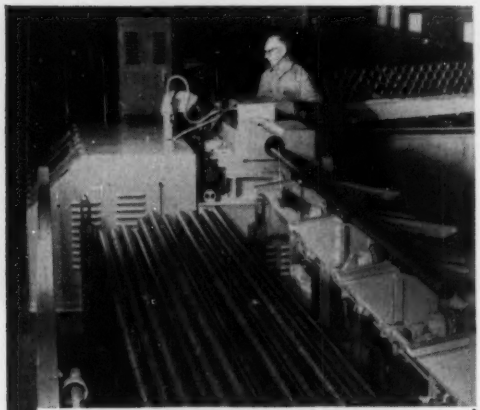
The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

M KELLOGG W



Quality tested, quality protected Republic ELECTRUNITE Heat Exchanger Tubes slide in easy, slide in to stay. Photo courtesy, The M.W. Kellogg Company, New York, N.Y., leading designers and manufacturers of heat exchangers.

only ELECTRUNITE Heat Exchanger Tubes offer QUALITY YOU CAN MEASURE



FARROWTEST—DETECTS AND REJECTS

Wall Thickness	Minor Dimension of the Defect (Length or Depth)	Length X Depth Area in Square Inches
20 ga.	.006″	.0025″
18 ga.	.006″	.003″
16 ga.	12½% of Wall	.003″
14 and 13 ga.	12½% of Wall	.004″
12 ga. and heavier	12½% of Wall	.005″

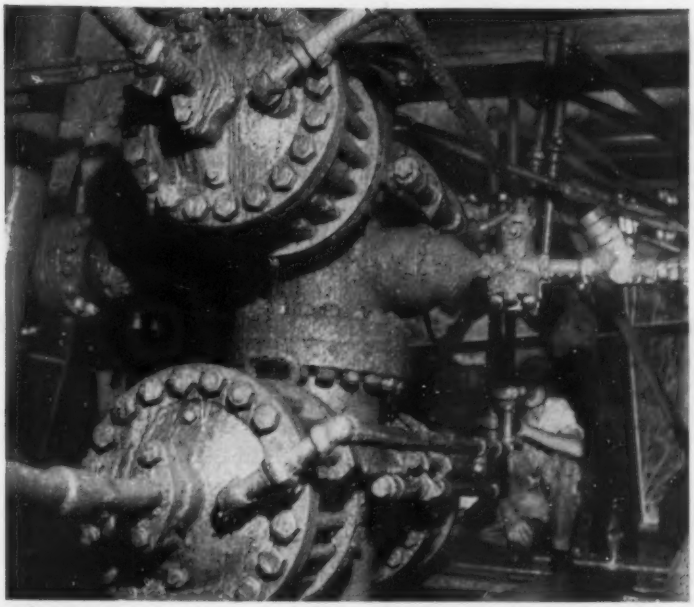
Quality is built-in! Only ELECTRUNITE® Heat Exchanger Tubes are produced by Republic—one integrated, responsible producer who controls quality from mine to finished product. ELECTRUNITE is formed from highest quality flat-rolled open-hearth steel and electrically-welded by the exclusive ELECTRUNITE process that unites the tube under pressure without the addition of foreign metal.

The ELECTRUNITE process assures uniformity of wall thickness, strength, ductility, concentricity, diameter, physical and other properties to meet critical performance specifications.

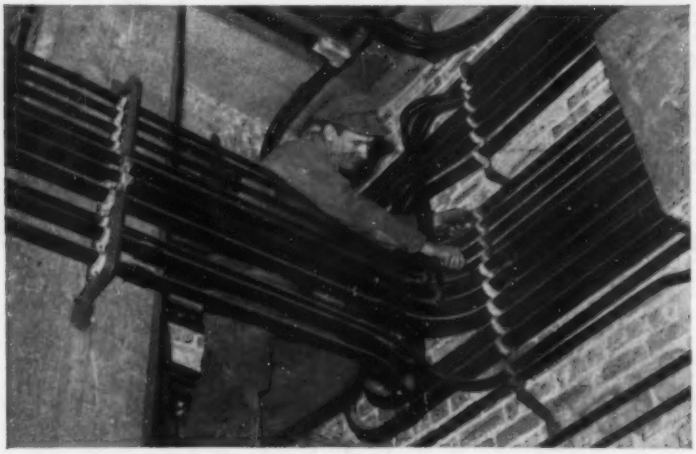
FARROWTEST®—*quality you can measure.* Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects defects of critical size. The additional quality protection of exclusive FARROWTEST is offered as an alternative to other less positive tests . . . at no extra cost.

Get the facts first-hand. Call your Republic representative, or write direct, to learn more about the advantages of Republic's exclusive ELECTRUNITE.

FARROWTEST detects and rejects defects completely penetrating tube wall, or equal to, or greater than, those shown in the table, left. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.



REPUBLIC ALLOY STUDS AND HIGH CARBON HEX NUTS team up perfectly to withstand major stress imposed on a wide variety of petroleum processing and oil field equipment, like the blowout preventer shown here. Clean accurate threads provide high strength and wear resistance, plus ease of assembly and disassembly required for equipment maintenance. Republic has fasteners for every application. Send for information.



EXTEND PRODUCT QUALITY CONTROL WITH REPUBLIC STEEL CONTAINERS. Republic manufactures a full line of steel containers to help you extend control of product from your shipping floor to point of use. Through proper selection, you can be sure that product quality, as received, will produce maximum customer satisfaction and profitable repeat business. For more information write for full line catalog.

REPUBLIC ELECTRUNITE "DEKORON®-COATED" E.M.T., in service nearly seven years at the Charmin Paper Products Company, Green Bay, Wisconsin, has outlasted standard conduit ten to one. A tough coating of polyethylene encases lightweight, strong ELECTRUNITE E.M.T. in an end-to-end armor that is impervious to corrosive atmospheres. Protect your electrical raceways with Republic "Dekoron-Coated" E.M.T. Send for additional data.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. PR-6063
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send additional information on the following:

☐ Republic ELECTRUNITE Heat Exchanger Tubes
☐ FARROWTEST ☐ Alloy Studs—High Carbon Hex Nuts
☐ Republic Containers ☐ "Dekoron-Coated" E.M.T.

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

BJ

pumps and mechanical seals for refineries

For special engineering assistance or for further information about Byron Jackson pumps and mechanical seals, contact your nearby BJ sales office or write Byron Jackson Pumps, Inc., P.O. Box 2017 Terminal Annex, Los Angeles 54, Calif.

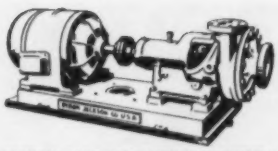
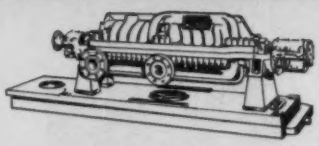


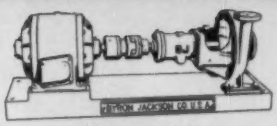
FIGURE 1025-1125 PROCESS PUMPS

Moderately priced pumps for general-purpose handling. Available with BJ Mechanical Seal. Capacities to 2000 gpm, heads to 800 ft. Temperature limit 350°F. Write for Bulletin 353-300.



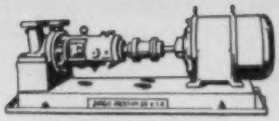
MULTIPLEX PUMPS

Recommended for boiler feed, debarking and all classes of medium-to-high pressure and temperature service. Easy inspection or cleaning without disturbing piping, bearings or driver.



CHEMICAL PUMPS

Specially engineered to handle corrosive liquids. Fitted with BJ Mechanical Seal with all major parts of seal isolated from pumped liquid. Positive protection against leakage to bearings or contamination of pumped liquid.



SM PROCESS PUMPS

For pumping fluids over a wide range of pressures and for temperatures up to 800° F. Ideal for pumping hot or cold liquids near their vapor pressure. Capacities to 4500 gpm and heads to 1900 ft.

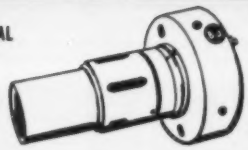
VERTICAL CIRCULATING PUMPS

Single or multi-stage. For pumping medium to high capacities of water. Capacities to 50,000 gpm. Saves space, simplifies piping. For dewatering, drainage, river intake, circulating and sump services.

SMI PROCESS PUMP

This general purpose pump features a BJ mechanical seal as a functional part of its design. It is built for continuous duty and temperatures to 400°F. Easily dismantled and reassembled without disturbing suction or discharge connections. Construction materials to suit application. Sizes: 1½ thru 6" suction, 1 thru 4" discharge. Capacities to 1500 gpm. Heads to 700 ft.

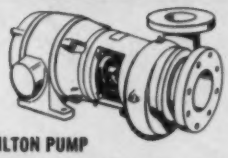
MECHANICAL SEALS



Replace standard packing in stuffingboxes. Eliminate excessive leakage and frequent repacking. Recommended for corrosive, high temperature or volatile liquid pumping. Prevent contamination of pumped liquid.

DOUBLE SUCTION HOT OIL PUMP

Developed for capacities beyond the range of single suction process pumps. Designed to handle high temperature liquids on continuous service operation. Rotating element can be removed as a unit without disturbing the piping or driver. Capacity range from 1000 to 7000 gpm, heads from 100 to 700 feet. Construction materials to suit application.



BILTON PUMP

A general-purpose, close-coupled pump and motor unit. Mounts in any position with no rigid base needed. Especially useful where space is limited. Available with explosion-proof motor. One-third to sixty hp. Capacities to 2000 gpm and heads to 475 ft.

TYPE VMT PUMP

May be designed for pumping liquids from sub-zero to 750° F.—corrosive or non-corrosive—where NPSH is limited. Capacities to 9000 gpm and heads to 575 ft. Smaller standardized (VLT) models also available in capacities to 240 gpm.

SUBMERSIBLE PUMPS

For well pumping, booster stations, or for standby service. Pump and sealed motor operate completely submerged. No pump house or surface structure needed. No well too deep. Ideal where flood menace exists. Capacities to 20,000 gpm and heads to 1800 ft. Write for Bulletins 55-2-700 and 55-3-700.

HYDROPRESS PUMPS

For medium to high pressure pumping at low capacity. Vertical construction saves space, simplifies installation. No relief valves required. Uniform nonpulsating flow. Capacities to 600 gpm. Heads to 10,000 ft.

LIQUID OXYGEN PUMP

Handles liquid oxygen or nitrogen at temperatures as low as –300°F. Insulated section between pump and stuffingbox keeps leakage to a minimum. Standard capacities to 1500 gpm. Heads to 4000 ft. Greater requirements possible by special design.

cations will be presented at Salt Lake City during the National Meeting of the AIChE Sept. 21-24 in the Hotel Utah.

Technical sessions will begin on Monday, Sept. 22. Subjects that will be discussed in the 23 sessions of the four-day meeting include industries in the intermountain region, alternate energy sources, thermodynamics, improved utilization of technical manpower, centrifugation, air pollution, ethylene and fluid mechanics. In addition, there will be a special safety conference and a panel discussion on the subject of financing research.

Products Imports Excessive Says Petroleum Association

Higher imports of refined products have helped offset reductions in crude oil imports under the voluntary oil imports program, the Independent Petroleum Association of America said recently in its monthly supply and demand outlook. It reported that while crude oil in the May-June period is 230,000 bpd below the same months last year, imports of products were up 185,000 bpd.

During the latest three months, total new crude supply averaged 8.7 million bpd, the association said, down about 843,000 bpd from the corresponding 1957 period. The outlook noted that domestic production accounted for most of the decline, being down about 800,000 bpd.

Domestic demand during September-November is expected to increase 268,000 bpd, or 3.1 percent above the same level for a year ago. But export demand is expected to decline about 85,000 bpd from the 1957 level and average about 270,000 bpd. So total domestic and export demand for September-November is expected to average 9.1 million bpd, two percent higher than this time last year.

Domestic petroleum consumption during May-June this year reflected the best percentage increase for any three month period in more than a year, the association reported. Consumption during that period averaged 8.3 million bpd, an increase of 2.3 percent over the same months in 1957.

U. S. inventories of crude oil at the end of July were down about 41 million barrels. Total crude oil and product inventories slipped to 775 million barrels, down 44 million barrels from July, 1957.

The total new supply required during September-November, is expected to average about 9.3 million bpd. Total imports are expected to average 1½ million bpd. Domestic production of natural gas liquids is estimated at 800,000 bpd. The market for domestic crude oil is expected to average about 7 million bpd during the September-November period, about the same as in August, the IPPA added.

Israel Interested in Plant At Haifa, Owned by BP-Shell

Israel's Ministry of Finance is reportedly looking into the possibility of buying the 80,000-bpd Haifa plant of Consolidated Refineries, a British Petroleum Co.-Shell Oil Co. enterprise, with intention to boost throughput closer to capacity than the present 24,000 bpd.

Government sources say Israel is looking for foreign companies as partners to put up funds for purchase and operation of the refinery. These sources say that talks have taken place between the Ministry of Finance and the refinery's owners, who are reported willing to negotiate.

Creole Foundation Offers $10,000 Science Topic Prize

A $10,000 biennial prize for the best work written about Venezuela in the fields of natural, physical or social sciences will be offered by the Creole Foundation. To be eligible, manuscripts may be submitted from anywhere in the world and may be in Spanish, English, French, Portugese, German or Italian. Works presented in another language must be accompanied by a summary in one of the six eligible languages.

Entries for the $10,000 prize will be accepted until December 1, 1959, to be eligible for the first award to be made in October, 1960. A biographical sketch of the author should be included with the entry.

A sponsoring committee composed of Arturo Uslar Pietri, Miguel Layrisse, and Francisco Duarte has been formed to administer the competition.

The prize winner will be invited to Caracas, the Foundation's headquarters, for a presentation ceremony. Further details may be obtained from the Creole Foundation, Apartado 889, Caracas, Venezuela.

What's Happening. . .

HOW MANY YEARS WILL A GOOD LINING LAST?

Make it with Hexmetal

AND DOUBLE THE NUMBER YOU FIRST THOUGHT OF

A lining lasts as long as its bonding properties.

The natural organic bond of refractory clays and the chemical set of concrete all fail eventually under the stresses imposed upon them. When a lining is "bonded" or given "bone" by Hexmetal Reinforcement, it holds in position long after all its natural bond is burnt out by heat or chemical action. The independent pinned joint of Hexmetal cells give twice the life of other reinforcements with lug joints.

Industry is year by year proving the value of these claims in Flues, Ash-Pits, Reactors, Cyclones, Cat Crackers, Coke Hoppers, Down Comer Pipes, Hydroformers, Water Turbine Flumes, Underground Galleries, etc.

Write or telephone for fullest details.

CAUSEWAY REINFORCEMENT LIMITED
66 Victoria Street, London, S.W.1 England (Victoria 8648)
CABLES: Hexmetal, London.

For more data on advertised products, use Readers' Service Cards, last page.

—Changing Times—

Bishop Oil & Refining Co. has abandoned plans to build a $19 million refinery near Phoenix, Ariz. Bishop sought zone change to permit refinery, but opponents said smoke and fumes from plant **might cause smog problem.**

The merger of Crescent Petroleum and Norbute Corp. has been approved by stockholders of both companies. Terms provide that 20 shares of Crescent preferred and 5 common will be exchanged for each 100 shares of Norbute common.

Yacimientos Petroleferos Fiscales has received a Rumanian offer to sell $40 million worth of drilling equipment and refinery installations. Offer closely follows Soviet $100 million barter proposal, in which drilling gear would be swapped for wool, hides, and other Argentine exports.

Esso Standard has assured five members of Massachusetts Congress that **it has no intention of closing its 45,000-bpd Everett refinery.** Esso President Naden said **Esso is studying economic cutback, but no decision will be made during Middle East crisis.** He added that company will consider their arguments against curtailment of plants operations.

Justice Department has confirmed that **Federal Grand Jury in Hammond, Ind., has reinstituted investigation of gasoline price fixing charges against several midwest suppliers.** Conspiracy charges handed down last fall had been dismissed in July on grounds that jury had been improperly impaneled. Companies subpoenaed were not revealed.

Thirteen bulk fuel handling systems will be manufactured by Firestone for U.S. Marines. Units will cost $3 million, consist of an easily transportable "service station" for airplanes and combat vehicles. **System is made up of 42 rubber tanks with 10,000 gallon capacity, can be deflated in compact package when not in use**—provides 420,000 gallons of fuel readily available in combat areas.

Ente Nazionale Idrocarburi, Italy's state oil agency, has offered to supply Argentina's Yacimientos Petroleferos Fiscales 10 to 20 drilling rigs and refining and transport equipment in the form of a capital investment. ENI expressed interest in building a plant in Argentina for manufacture of such equipment.

Richfield Oil, Los Angeles, is negotiating with Idemitsu Kosan for **Japanese gasoline to be shipped to U.S. starting this month, in return for lube oil to be imported from U.S.** Contemplated volumes have not been disclosed.

Another important **new use has been found for the natural hydrocarbon** found only in the Uintah Basin of Utah, according to American Gilsonite Co., the firm who handles it. **The mineral has become the basis for a new cold bituminous concrete.** Mix can be poured cold, even under 35 F., is still workable after being stockpiled in the open.

Standard Oil Co. (Ind.) received National Safety Council's Award of Merit for accumulating a million man hours of operation without a lost time accident at the company's El Segundo refinery. Record is six weeks longer than any previous continuous accident-free period in 46 years of operation.

British Petroleum has formed a new firm, British Overseas Refining, to hold parent countries interest in future overseas refineries. Present function of **new firm is to hold BP's 11 percent interest in a 65,000-bpd refinery being built in Turkey** by BP, Shell, Mobil Overseas, and Caltex.

Standard of Indiana has announced that **Imperial Chemical Industries Ltd. has been licensed to use its new process for making aromatic acids,** in plant near Middlesbrough, England. The 30 million-pound-per-year terephthaltic acid **plant is the fourth to use the process.** Others are two Japanese plants and an Amoco Chemical Corp. unit in Joliet, Ill.

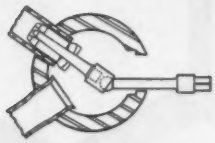
Maritime Administration and Atomic Energy Commission reported that **Bunker C Fuel prices will increase to about $3.10 per barrel by 1960-1965** (average of San Pedro, Calif.; Gulf Coast, and New York Harbor prices) **making atom power more competitive.** Statement was made at the groups' second annual one-day symposium.

WIEDEKE

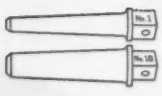
THE QUALITY NAME IN TUBE EXPANDERS . . . SINCE 1892

Tube Expanders for Water Tube Boilers

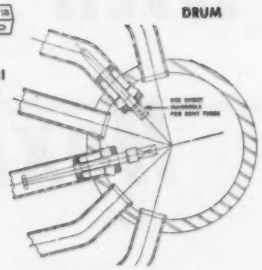
Series 1500



With Short Mandrel; Universal Joint Drive for Superheater Header.

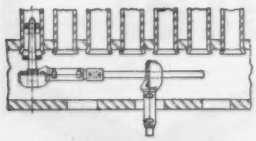


Short Mandrels—all sizes, in 3 lengths



DRUM

With drum Mandrel for straight tubes; use short Mandrels for bent tubes.



With Short Mandrel and Right Angle Gear Drive; for round or square headers.

#38

IDEAL

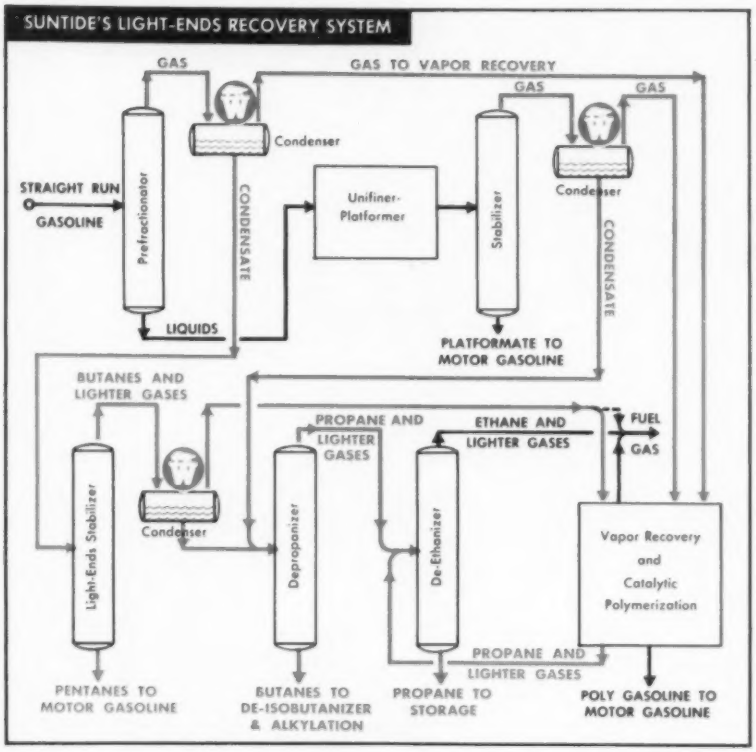
Continuous research and development in Tube Expanders, Tube Cutters and Operating Accessories for condensers and boilers has been going on at The Gustav Wiedeke Company since 1892. The IDEAL Trademark is your guarantee of quality. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Products. Wiedeke Distributors in principal cities. Write for *new* General Catalog 81.

The Gustav WIEDEKE Company

Dayton 1, Ohio

WOLVERINE
TUBE
Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE



Payout in less than a year

SUNTIDE BOOSTS LIGHT ENDS RECOVERY

BY ERNEST DODD

Because of its ability to increase the throughput of existing heat exchangers and condensers, Wolverine Trufin® Type S/T—the integrally finned tube—was used to tube many exchangers in Suntide Refining Company's new light-ends-recovery system installed recently at Corpus Christi, Texas. Suntide is an affiliate of Sunray Mid-Continent Oil Co.

To reduce installation costs, Suntide designed its new light-ends-recovery system so that it would take full advantage of existing facilities and equipment. Because of the increased efficiency achieved in recovery of light ends, Suntide expects payout to occur in less than a year.

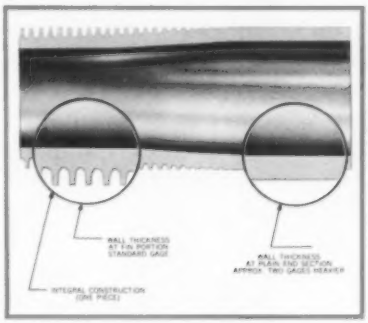
Installations such as this are made to order for Wolverine Trufin Type S/T. Since it is an extended surface tube, with fins extruded directly from the tube wall, Trufin Type S/T has approximately 2½ times more surface area than plain tube. Because of this it is possible to pack more heat transfer surface into a given area—thus stepping up the capacity of existing equipment.

Also of major importance is the fact that Trufin Type S/T is interchangeable in shell and tube heat exchangers and condensers with the prime surface tube it was designed to replace. In fact only standard tools and retubing techniques are required.

Wolverine Trufin Type S/T is available in a wide range of sizes in copper and copper alloys, aluminum and steel. Next time you consider heat exchanger tube specify Wolverine Trufin Type S/T —realize the increased heat transfer performance this integrally finned tube makes possible. Write for complete information.

WOLVERINE TRUFIN® TYPE S/T IS ENGINEERED FOR THE JOB

Wolverine Trufin Type S/T is specifically engineered for use in shell and tube heat exchangers and condensers. The cutaway illustration, below, graphically shows its unique, one-piece construction. Because of this, Trufin Type S/T gives constant performance over a longer period of time. Fins are unaffected by vibration, thermal shock or pressure variations.

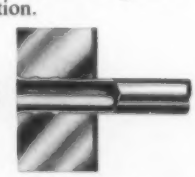


EASY TO INSTALL

Here's proof (in the drawings below) that Trufin Type S/T rolls into headers as easily as does plain tube. Standard rolling-in methods only are necessary —there is no deviation from existing fabrication procedures.

Wolverine Trufin Type S/T is the original, integrally finned condenser tube. It was developed and pioneered by Wolverine Tube. Over the years Wolverine Tube has compiled a great deal of heat transfer information—particularly in the field of finned tube applications. If you have a problem — don't hesitate — ask for the assistance of a Wolverine Field Service Engineer. There is no obligation.

Wolverine Trufin Type S/T Condenser Tubing



Prime Surface Condenser Tubing

prefabricated to your specifications and shipped in exact installation order

save space and reduce inventory problems

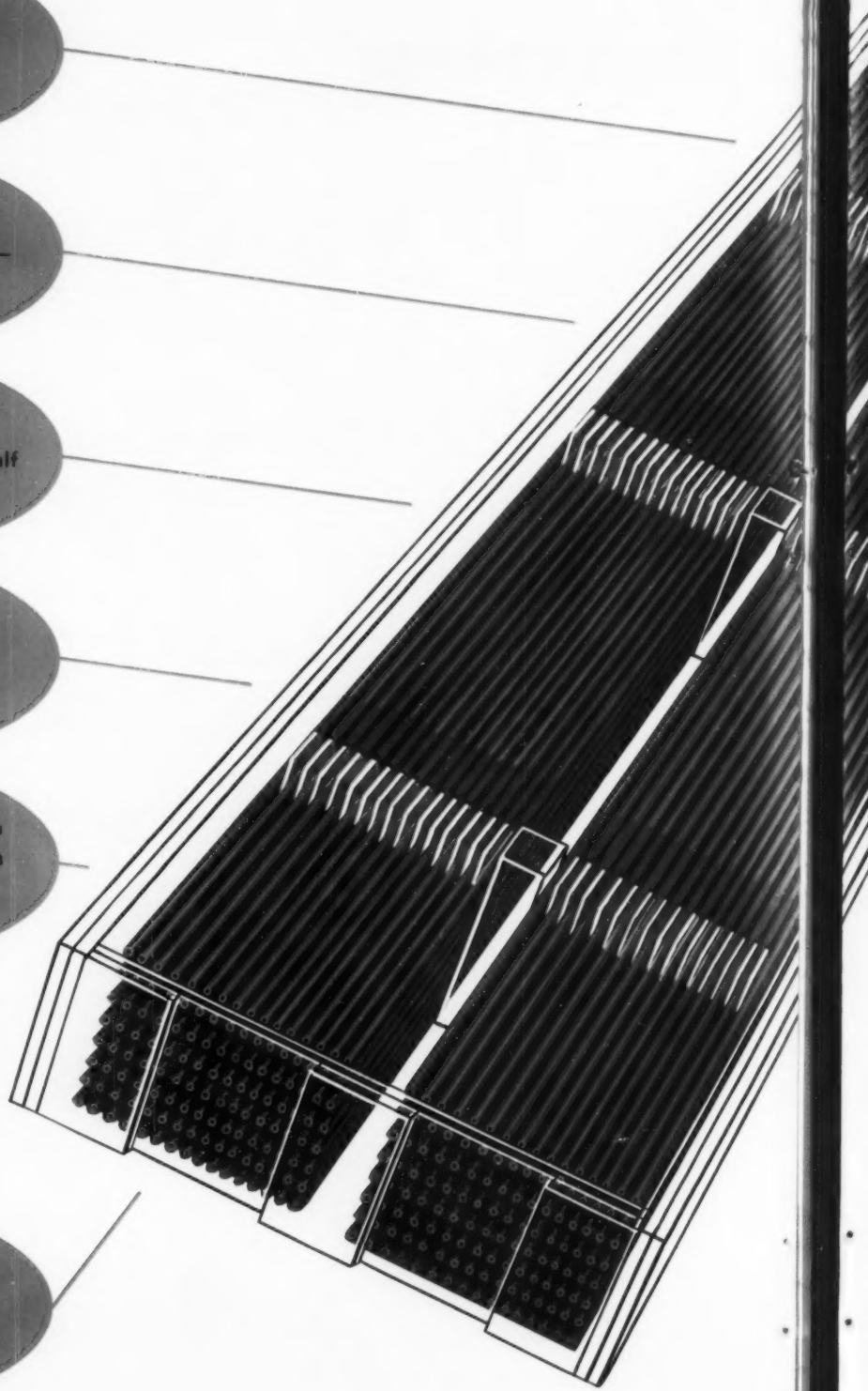
eliminates one tube sheet—

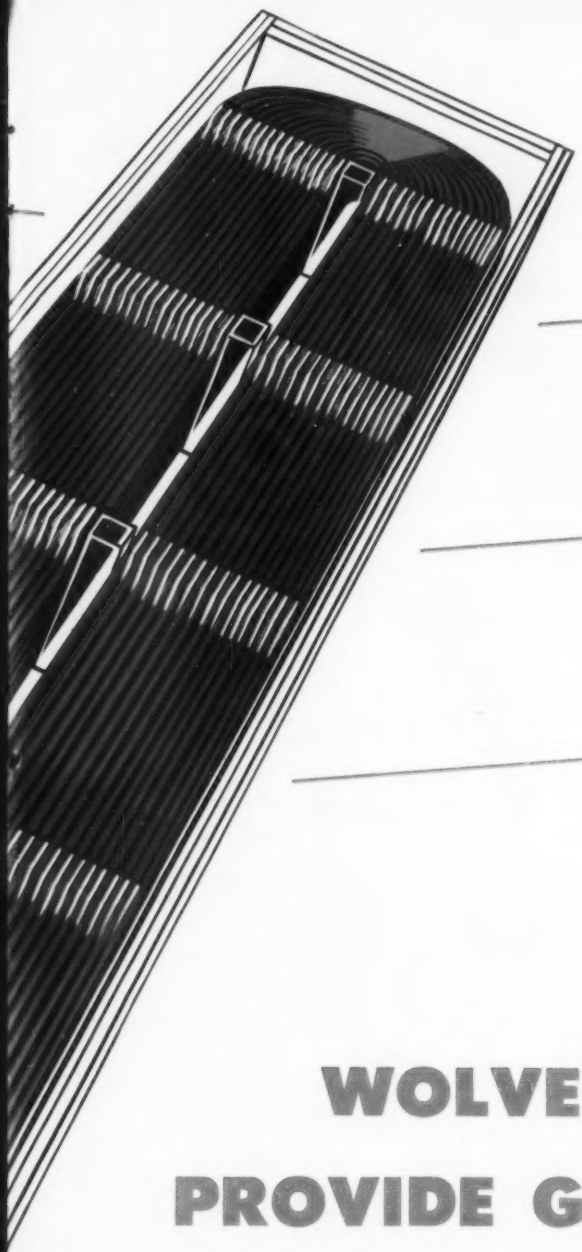
cut rolling-in operations by half

available in prime surface form or with integral fins

provide easier transportation and handling—particularly in tubes over 30 feet in length

make installations easier and faster





shipped in disposable box type pallets

available in copper, copper alloys, aluminum, seamless steel

stock complete installations, use when needed

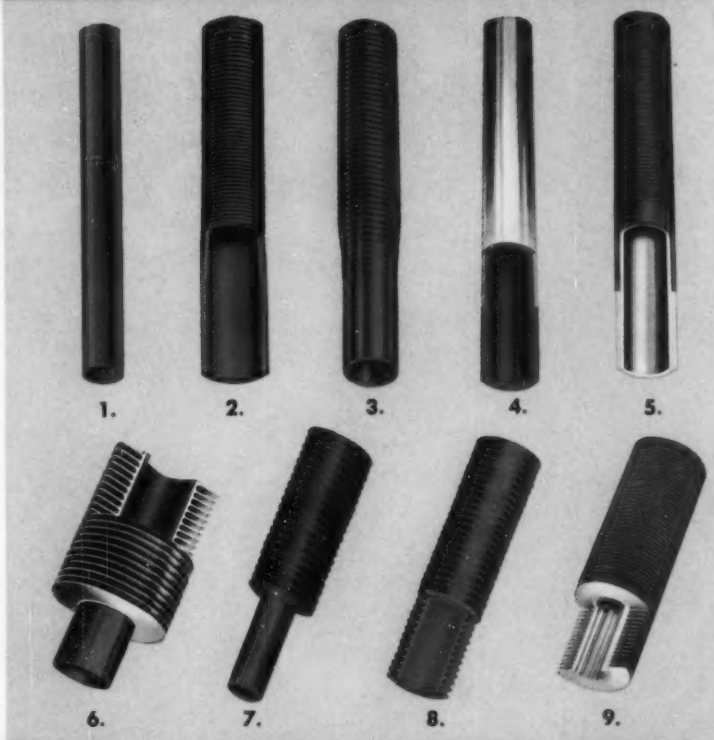
WOLVERINE U-BENDS PROVIDE GREATER ECONOMY AND GREATER CONVENIENCE

You can save time and money by specifying prefabricated Wolverine U-bend condenser tubes in either finned (Wolverine Trufin) or prime surface form. Wolverine bends these tubes to your specifications—ships them to you in the exact order of installation in disposable box-type pallets. Check the advantages listed above and then the next time you retube specify Wolverine U-bend condenser tubes. Write for complete information or talk to your Wolverine Sales Representative.

CONDENSER TUBES FOR EVERY JOB

From its years of experience in the heat transfer field Wolverine Tube has developed a condenser tube lineup designed to meet every need. Engineers can, for example, specify prime surface tube . . . integrally finned (Wolverine Trufin) or duplex tubing . . . all in a wide range of sizes and alloys. Next time you specify heat exchanger tubing remember that Wolverine Tube can meet *ALL* your needs.

1. **PRIME SURFACE TUBE**
2. **WOLVERINE TRUFIN TYPE S/T**
3. **WOLVERINE TRUFIN TYPE W/H**
4. **PRIME SURFACE DUPLEX TUBE**
5. **WOLVERINE TRUFIN—DUPLEX**
6. **WOLVERINE TRUFIN TYPE L/C**
7. **WOLVERINE TRUFIN TYPE H/R**
8. **WOLVERINE TRUFIN TYPE H/A**
9. **WOLVERINE TRUFIN TYPE I/L**



TECHNICAL HELP FOR EVERY JOB

R. B. DAVIS
8941 Schaefer Hwy.
Detroit 28, Mich.
WE 1-0783

J. A. MARSHALL
148 Spear St.
San Francisco 5, Cal.
SU 1-7222

H. J. LUETZOW
Room 4004
60 East 42nd St.
New York 17, N. Y.
MU 2-8430

A. L. CLAES
Room 1408-10
Liberty Trust Bldg.
Philadelphia 7, Pa.
RI 6-1442

H. F. POWELL
2 North York St.
Corner of Commerce
Houston 3, Texas
CA 2-6191

B. E. WESSELS
2 North York St.
Corner of Commerce
Houston 3, Texas
CA 2-6191

M. A. WALLACE
P. O. Box 569
Nat. Bank Bldg.
Evanston, Ill.
Evanston—DA 8-8616
Chicago—RO 4-7412

If you're having trouble with heat transfer problems . . . such things as equipment design or alloy selection you can obtain expert help real fast. Just get in touch with one of Wolverine Tube's Technical Sales Representatives. They're as close as your telephone and because of their specialized training are fully qualified to help you solve the most difficult problems. Call on them next time you need help.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO. LTD.
UNIFIN TUBE DIVISION

WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17236 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES
EXPORT DEPT. 13 E. 40TH STREET, NEW YORK 16, NEW YORK

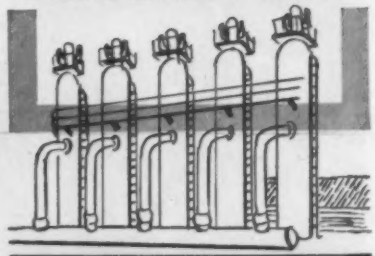
Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

MEETINGS CALENDAR

SEPT.	
18	Natural Gasoline Assn. of America, Rocky Mountain Regional Meeting, Gladstone Hotel, Casper, Wyoming.
21–24	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Cosmopolitan Hotel, Denver.
21–24	American Institute of Chemical Engineers, 38th National Meeting, Hotel Utah, Salt Lake City.
22–24	Standards Engineers Society, 7th Annual Meeting, Benjamin Franklin Hotel, Philadelphia.
24–25	Western Petroleum Refiners Assn., Rocky Mountain Regional Technical-Industrial Relations Meeting.
28–Oct. 1	American Society of Mechanical Engineers' Power Conference, Hotel Statler, Boston.
OCT.	
1– 2	Western Petroleum Refiners Assn. Third Annual Stream Poilution and Waste Disposal Conference, Lassen Hotel, Wichita.
3	American Institute of Chemical Engineers, 13th Annual Meeting of the South Texas Section, Moody Center, Galveston.
6– 7	National Association of Corrosion Engineers, Southwest Regional Meeting, Hotel Jefferson, Richmond, Va.
6– 8	National Assn. of Corrosion Engineers, Northeast Regional Meeting, Boston.
9–10	California Natural Gasoline Assn., 33rd Annual Fall Meeting, Huntington-Sheraton Hotel, Pasadena, Calif.
9–10	American Society of Mechanical Engineers and American Institute of Mining Engineers, Conference on Fuels, Old Point Comfort Hotel, Old Point Comfort, Va.
13–15	American Institute of Electrical Engineers, 14th Annual Forum on Electrical Research, Development and Application, Hotel Sherman, Chicago.
13–15	American Gas Assn., Annual Convention, Atlantic City, N. J., Site Unreported.
15–17	National Association of Corrosion Engineers, North Central Region Meeting, Cincinnati, Site Unreported.
15–17	Second Energy Resources Conference, "Energy and Its Impact on Society," Brown Palace Hotel, Denver.
19–21	National Assn. of Oil Equipment Jobbers, Annual Convention and Trade Show, Hotel Adolphus, Dallas.
20–21	Instrument Society of America, National Rubber and Plastics Instrumentation Symposium, Akron, Ohio, Site Unreported.
20–22	Society of Automotive Engineers, National Transportation Meeting, Lord Biltmore Hotel, Baltimore.
20–24	National Assn. of Corrosion Engineers, Annual Conference and Exhibition of South Central Region, Roosevelt Hotel, New Orleans.
22–24	American Petroleum Institute, Meeting of Committee on Disposal of Refinery Wastes, Statler-Hilton Hotel, Dallas.
22–24	Society of Automotive Engineers, National Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.
23–24	Western Petroleum Refiners Assn., Session on Refinery Technology and Industrial Relations Meeting, Rufus Garrett Hotel, El Dorado, Ark.
27–28	International Petroleum Assn. of America, Annual Meeting, Statler-Hilton Hotel, Dallas.
31	Natural Gasoline Assn. of America, Southern Regional Meeting, Carlton Hotel, Tyler, Texas.
NOV.	
5– 6	Society of Automotive Engineers, National Fuels and Lubricants Meeting, The Mayo Hotel, Tulsa.
NOV.	
6–7	Louisiana Polytechnic Institute, 7th Annual Instrumentation Conference, On Campus, Ruston, La.
10–13	American Petroleum Institute, 38th Annual Meeting, Conrad-Hilton, Palmer House & Congress Hotels, Chicago.
17–19	National Association of Corrosion Engineers, 8th Western Region Meeting, Statler Hotel, Los Angeles.
18–20	American Petroleum Institute, 9th National Conference on Standards, Hotel Roosevelt, New York City.
21	National Gasoline Association of American, Panhandle Plains Regional Meeting, Herring Hotel, Amarillo.
30–Dec. 5	American Society of Mechanical Engineers, Annual Meeting, Statler & Sheraton-McAlpin Hotels, New York City.
DEC.	
3– 5	American Petroleum Institute, Oil Information Committee Meeting, Waldorf-Astoria Hotel, New York.
4– 5	Industrial Engineering Conference, Sponsored by Illinois Institute of Technology, Chicago.
7–11	American Institute of Chemical Engineers, Annual Meeting, Netherland Plaza Hotel, Cincinnati.
JAN. 1959	
12–14	National Association of Corrosion Engineers, Eastern Regional Meeting, Montreal Quebec, Site Unreported.
23	National Gasoline Association of America, Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City.
28–29	Midwest Welding Conference, Sponsored by Armour Research Foundation and Chicago Section of American Welding Society, At Illinois Tech, Chicago.
FEB.	
2– 6	American Society for Testing Materials, Committee Week, William Penn Hotel, Pittsburgh.
11–13	National Association of Corrosion Engineers, Western Regional Meeting, Calgary, Alberta, Site Unreported.
27	National Gasoline Association of America, Permian Basin Regional Meeting, Schorbaur Hotel, Midland, Texas.
MAR.	
1– 5	American Society of Mechanical Engineers, Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati.
8–12	American Society of Mechanical Engineers, Aviation Conference, Statler Hotel, Los Angeles.
9–11	Midwest Gas Association, Annual Meeting, Hotel Fort Des Moines, Des Moines.
16–20	National Association of Corrosion Engineers, 1959 Corrosion Show and 15th Annual Conference, Sherman Hotel, Chicago.
16–20	American Society for Metals, et al, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
APRIL	
5–10	Instrument Society of America, Nuclear Congress, Cleveland Auditorium, Cleveland, Ohio.
19–23	American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Shamrock-Hilton Hotel, Houston.
22–24	National Gasoline Association of America, 38th Annual Convention, Baker and Adolpus Hotels, Dallas.

FEWER "TURN-AROUNDS"



Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

★

"A Fitting Grating for Every Purpose"

IRVICO

IRVING SUBWAY GRATING CO., Inc.

Originators of the Grating Industry

Offices and Plants at
5090 27th St., LONG ISLAND CITY 1, N. Y.
1890 10th St., OAKLAND 23, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

Harry A. Brown, right, checks final job assignments with the new management team at D-X Sunray Oil Co.'s 75,000-bpd refinery in Tulsa. T. L. Tiernan, seated at desk, has been named the new general manager for the plant. Others, seated left to right, are Art Field, new manager of operations services; John Holiway, new manager of light oils; and Pierce Reynolds, new manager of technical services. Standing, left to right, are E. T. W. Hall, new manager of administrative services; Carl Larson, new manager of lubricating oils; and N. B. York, assistant to the general manager.

Three science and mathematics teachers hired at Shell Oil Company's Wilmington Refinery for the summer look over their work schedules with C. G. Peterson, at left, assistant refinery superintendent.

The educators, from left to right, Robert Jones, Robert Dopp, and Jesse Levine, were placed in their summer positions through a unique "Industry-Education Program for Mathematics and Science" aimed at improving the general level of science instruction in the city schools.

Gene Hart has been named by Gulf Publishing Co., Houston, to the newly created position of sales manager of PETROLEUM REFINER and THE REFINERY CATALOG. Hart has been with Gulf Publishing Co. for eight years, and for the past six years has been associated exclusively with PETROLEUM REFINER and THE REFINERY CATALOG as district manager in the New York territory. He attended the University of Wichita where he majored in business administration. Hart's new headquarters are in Houston, home office of PETROLEUM REFINER.

A. F. Lucadamo will replace Hart as district manager in New York. He received his B.S. degree in chemical engineering from Pennsylvania State College, and did graduate work at Boston College and Massachusetts Institute of Technology. He spent more than seven years at the American Oil Co. refinery in Texas City where he worked in process design, technical services and coordination, and economics. For the past three years he has been technical sales engineer for American Oil Co., Boston.

Charles A. Cone has been elected president of Oil States Engineering Co., Tulsa. He was formerly vice president of Dresser Engineering Co.

W. G. Storey, former vice-president of Trend Construction Co., Oklahoma City, is now vice-president of Oil States.

A. C. Young, secretary-treasurer of the company was former chief mechanical engineer for Dresser Engineering Co.

Cone has a B.S. degree in civil engineering from the University of Oklahoma.

William M. Grass has been named Eastern division purchasing agent for Tidewater Oil Co. He joined the company in 1924 as a clerk at the New York office, and held supervisory posts in Albany and Newark prior to being appointed division accessory sales supervisor in 1951.

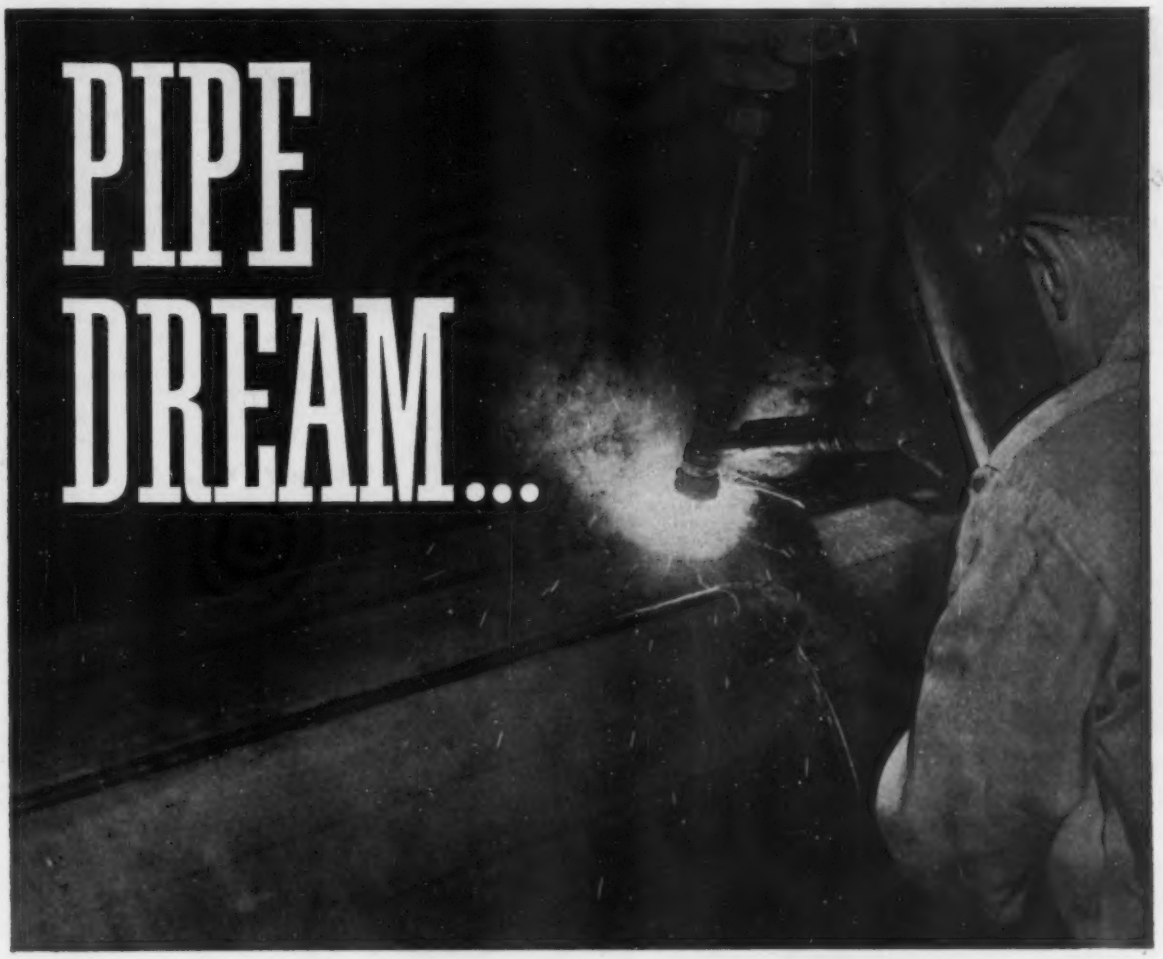
Kent H. Smith, board chairman of the Lubrizol Corp. and a member of the Case Institute of Technology board of trustees, has been named acting president of the school. He will serve until the return of Case President **T. Keith Glennan**, who is on leave of absence as the head of the National Aeronautics and Space Administration in Washington.

Eldon A. Siegman has been named senior financial analyst in the Financial and Planning division, Controller's department, New York offices of American Oil Co.

Siegman, who joined the Research and Development department in 1946 as a chemical engineer, is a graduate of Rice Institute where he received a B.S. degree in chemical engineering in 1944.

Craig Thompson, former newspaperman and free lance writer, has been appointed director, public relations, for Gulf Oil Corp. In 1930, he began a 13-year association with the "New York Times"

PIPE DREAM...



...UNIONARC Welding saves $7000 on one production run

UNIONARC Welding—LINDE's new electric welding method for steel—increased production by 300% and saved a western pipe mill $7000 on a single run of steel pipe. Replacing covered electrode methods, UNIONARC Welding is expected to save this company $150,000 a year.

UNIONARC Welding uses a continuously-fed wire electrode, magnetically coated with flux and shielded with carbon dioxide gas. It has three times the speed and weld penetration of covered electrode welding. And UNIONARC Welding gives you "finished", X-ray quality welds and low hydrogen deposits—in all welding positions.

See for yourself—ask your nearest LINDE representative to *prove* that UNIONARC Welding slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept. PR-9, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

"Linde", "Unionarc", and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Here's proof

Superior quality forged body —precision machined
Uniform wall thickness —no weak spots
Extra heavy reinforcing rim
Larger diameter cam ears for longer service life
Extra Hi-Strength forged handles —greater economy
Stainless Steel pins —greater safety and longer service
Uniform heavy wall thickness —no weak spots
Recess retains gasket in coupler and assures proper placement
Superior quality forged body —precision machined —accurate tolerances

your best buy is EVER-TITE -the best quality quick couplings

Bronze
Aluminum
Stainless
Carbon
Malleable
Hastelloy

You save time and money when you use EVER-TITE COUPLINGS, because you get speedy deliveries—no leaks.

The tightness is predetermined in manufacture so you can be *sure* with EVER-TITE.

The EVER-TITE trademark is a hallmark of dependability. EVER-TITES do the best job in the transfer of every type of product through hose or pipe.

Get EVER-TITE and get the *best*. Ask your distributor now.

EVER-TITE COUPLING CO. INC
254 West 54th Street
New York 19, N. Y.

Every EVER-TITE saves time and money

Men in the Industry . . .

as a reporter and foreign correspondent. He joined "Time Magazine" in 1943 as a contributing editor, and then served that publication as chief of its Moscow bureau, 1945-47. Thompson has been a free lance writer since 1949.

Domas Adomaitis has joined the Whiting Research laboratories of Standard Oil Co. (Ind.). He will conduct research on petroleum chemicals. Adomaitis, who has a degree in chemistry from Vytautas University, Lithuania, is a member of ACS. He was formerly with Marbon Chemical division, Borg-Warner Corp.

William W. Wingate has been named manager of the Mid-Continent region of Du Pont Co.'s Petroleum Chemicals division, with headquarters in Tulsa. He succeeds **Charles D. Towery**, who has been manager of both the Mid-Continent and Gulf Coast regions and now will devote full time to management of the Gulf Coast regional office in Houston.

Walter G. Ainsley, of Sinclair Research Laboratories, Inc., will be in charge of a company research office in Detroit for the purpose of maintaining a closer research liaison with the automotive industry. He will be coordinator in research between Sinclair and the automotive industry. Prior to his new assignment, Ainsley was Sinclair's director of Engine Laboratories, a division of Sinclair Research.

Bryant Franklin Kenney, 49, died in July after an illness of several months.

Kenney

He was a director of Standard-Vacuum Oil Co., and was a petroleum refining executive of international experience, responsible for Standard-Vacuum's six overseas refineries.

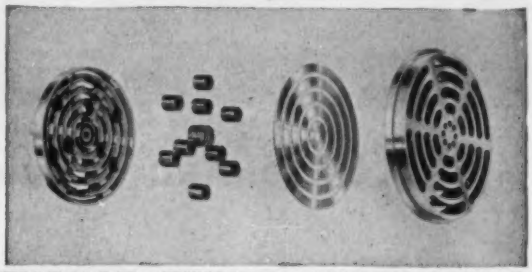
Kenney graduated from M.I.T. in 1930 with a B.S. degree in mechanical engineering, and undertook advanced management training at the Harvard Graduate School of Business Administration. He began his oil industry career in 1930 at the Bayway (N. J.) refinery of Esso Standard Oil Co.

William R. Kelly, assistant division manager of Sinclair Refining Co., Fort Worth, has been promoted to manager of the company's Rocky Mountain division, with headquarters in Denver. He succeeds **D. R. McCallum** who has been moved to Fort Worth as assistant to **O. F. Birkett,** manager of Sinclair's Southwestern division.

Kelly will be in charge of all Sinclair sales activities in Colorado, Idaho, Utah and Wyoming.

Kenneth E. Stanfield has received the U. S. Department of the Interior's Distinguished Service Award and Gold Medal for research achievements at the Bureau

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast) — VALVES and PLATES are of heat-treated alloy or stainless steel; PLATES are machined, not stamped, and ground for precise close-tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS, of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.

J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

"Take a tip from me—

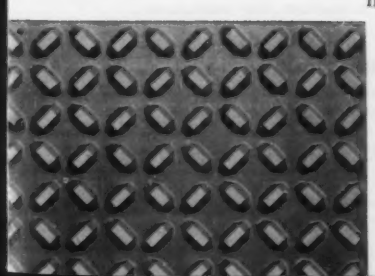
One slip can cost more than USS Multigrip"

USS* Multigrip Floor Plate is specifically designed to help protect you against accidents from slips and skids. It will pay you to look for possible accident-prone areas that could be made safe with Multigrip.* For it provides traction at all times—in all directions.

Where floor surfaces take a pounding, USS Multigrip supplies a rugged, long-lasting cover. It's made from heavy-duty plate that will last for years without maintenance. Studded with hundreds of risers in a symetrically designed pattern, their flat tops provide a greater bearing surface, reducing wear and prolonging the non-skid properties. Rugged though it is, it's comfortable to walk on and safe, wet or dry.

You save money on cleaning, too! A quick once-over with a broom or hose will get it spick and span. There are no pockets to hold dirt. Water drains quickly in any direction. Get USS Multigrip from our local distributor near you or write for more information.

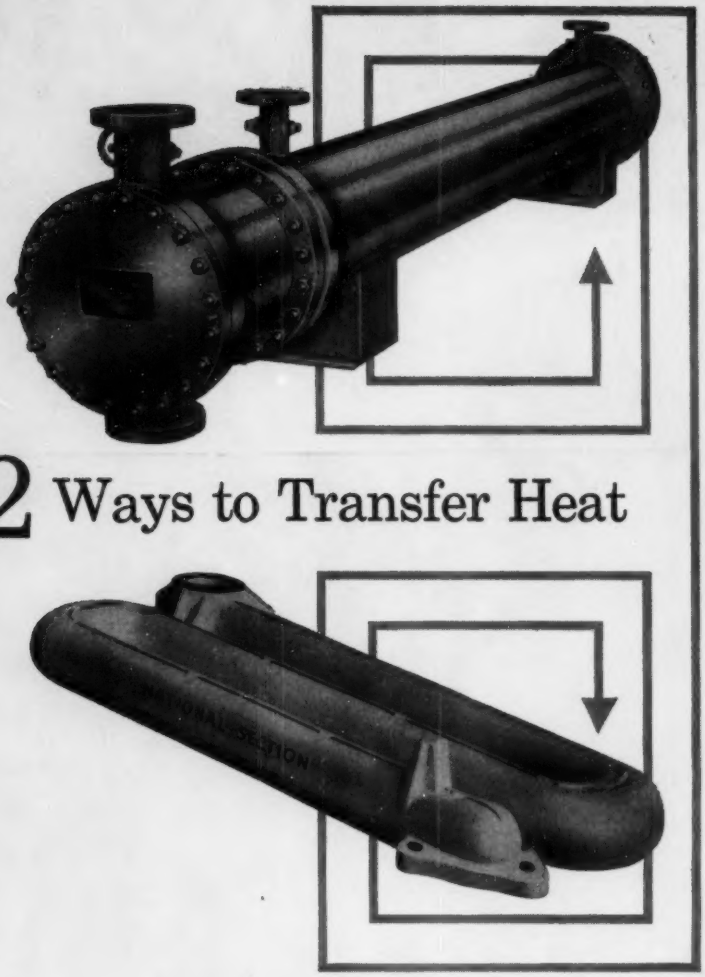
Sold by leading distributors from coast to coast



United States Steel Corporation – Pittsburgh
Tennessee Coal & Iron – Fairfield, Alabama
Columbia-Geneva Steel – San Francisco
United States Steel Supply – Steel Service Centers
United States Steel Export Company

USS United States Steel

*TRADEMARK



2 Ways to Transfer Heat

Problems of heat exchange and process cooling in the chemical and petrochemical industries are best solved when limitations of specific materials, shapes and fabrication methods are reduced to a minimum.

When National-U.S. engineers are called in early enough, they are frequently able to apply an unusual solution to a particular problem, because of their wide range of experience over a broad spectrum of industry. And *only* National-U.S. can offer *both* conventional heat exchange equipment in a complete range of metals *plus* units built from assemblies of corrosion-resistant cast iron.

Write for details, or see new edition of Chemical Engineering Catalog for name of nearest representative.

58-01

Heat Transfer Division

National-U.S. Radiator

CORPORATION

342 Madison Avenue • New York 17, New York

Men in the Industry . . .

of Mines' Petroleum and Oil-Shale Experiment Station at Laramie.

Stanfield began working at the station as a junior chemist in 1935 and for nine years directed the Bureau's first research program on petroleum asphalt. Since 1944 he has been in charge of the Bureau's studies on the constitution and composition of oil shale.

Stanfield is a graduate of the University of Wyoming where he received a B.S. degree in 1929 and a M.S. degree in 1931. After teaching and doing research at the University, he worked for several companies, and, for a short time, for the Bureau of Reclamation, before joining the Bureau of Mines.

W. G. Tierney is the new senior vice president of Colorado Oil and Gas Corp. Executive reassignments in the company and its subsidiary, Derby Refining Co., resulted from the retirement of **J. P. Moroney,** senior vice president, who joined the company in 1952.

Tierney

Tierney will divide his time between Wichita and Denver, serving as special assistant on refining and marketing. He will continue as president of Derby and as vice president and director of Colorado Oil and Gas.

L. W. Robbie has resigned his position as vice president and general manager, Republic Oil Refining Co., Texas City. **Charles H. Barre,** formerly assistant to the vice president, will become refinery manager at Texas City.

Robbie

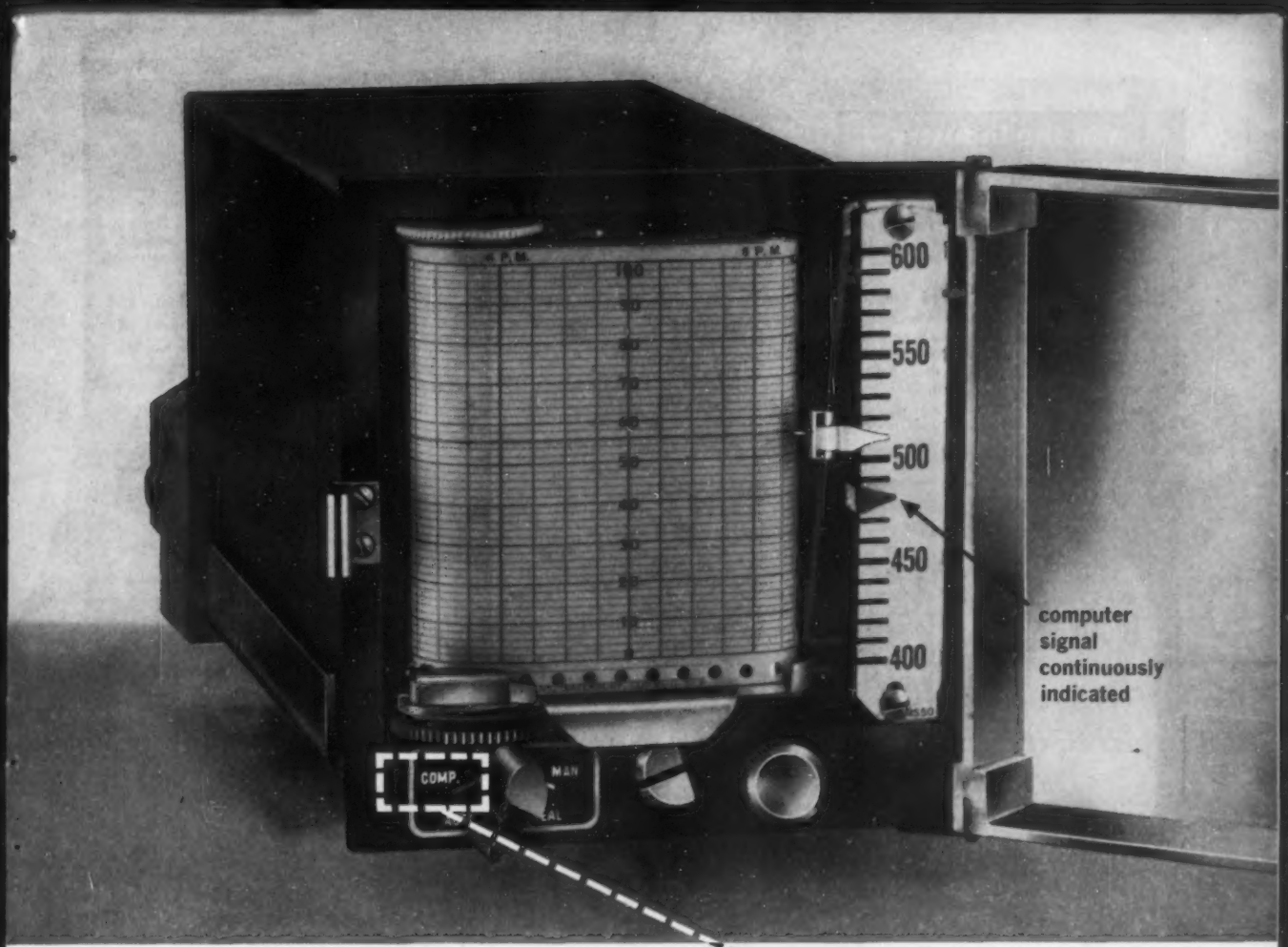
Robbie graduated from Armour Institute of Technology in 1936 with a B.S. degree in chemical engineering. He then joined Universal Oil Products Co. in the Engineering department where he spent ten years in construction and service operations. He joined Republic in 1947.

Maarten Voogd, manager of Shell Chemical Corp.'s Torrance, Calif., rubber plant will retire at the end of this year. He will go abroad in October on a special assignment for Shell, after which he plans to move to Ojai, Calif., and establish offices as a manufacturing consultant.

Dr. Phillip C. White has been named general manager of the Standard Oil Co. (Ind.) research and development department.

Pike H. Sullivan was named manager

For more data on advertised products, use Readers' Service Cards, last page.



World's first computer-controlled petroleum refinery unit will use Bristol control stations. New Bristol Metagraphic pneumatic receivers were specifically designed to meet requirements of computer-controlled processing. Write for full information.

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

111 Bristol Road, Waterbury 20, Connecticut

Men in the Industry . . .

of patents and licensing. Working with him will be **Arthur G. Gilkes,** appointed general patent attorney, and **Robert Gottschalk,** director of contracts and legal matters.

Richard R. Cecil has joined the technical staff of the Esso Research Laboratories, Baton Rouge, La. Other new staff members are **Elgin C. Edwards, Lewis G. McSwain, Jr., Harry V. Drushel, Edward B. Ellerbe** and **Edgar L. Steele.**

Mehemet Wiggen, technical specialist in the Technical division, Humble Oil & Refining Co.'s Baytown refinery, has retired. He had been with Humble at Baytown more than 37 years. Wiggen received the B.S. degree in chemistry at Washington State University.

Lloyd J. Beckman has been named secretary and director of Cities Service Oil Co. He succeeds **F. B. Plank.**

Beckman, who joined Cities Service in 1929 as assistant chief clerk of the Oklahoma Marketing Division, has been assistant secretary of the company since 1953.

J. E. Bounds, administrative vice president of Gulf Oil Corp., has been named coordinator of the Financial department. **W. T. Grummer** has been named acting comptroller and **W. L. Henry** director of taxes.

Bounds began his career with Gulf in 1929 as an accountant in Tulsa. Grummer joined Gulf in 1936 and was promoted to Assistant Comptroller in 1954. Henry joined Gulf in 1953. Before his present appointment he was manager, Income and Franchise Taxes department.

C. E. Carlson, superintendent, and **J. J. Casey,** assistant superintendent of the two rubber plants at Humble Oil & Refining Co.'s Baytown refinery, have retired. Both have been with Humble at Baytown more than 30 years.

Holland Howell joined the Refinery Engineering and Construction Co. of Houston as its president, September 1. He resigned as chief engineer at Republic Oil Refining Co. after 14 years of service.

Howell

Howell is past president of the Texas City Kiwanis Club, Galco Country Club, Galveston Philatelic Society and Texas Philatelic Society. At present he is district chairman for the Boy Scouts of America, and is a Mason and Shriner. Howell is also a member of the ASME, AWS, and API.

He received his education at Chamberlain-Hunt Military Academy, University of Cincinnati, Colorado School of Mines and the University of Texas.

Donald K. Hedeen has been promoted in the Planning Engineering division of Esso Research and Engineering Co. He has been named head of the General Planning and Economics section. Hedeen recently completed an eight-month engineering assignment in Cuba where he was involved in the start-up of a refinery built by an affiliate of Standard Oil Co. (N. J.)

Dr. Thomas L. Wilson has been appointed manager of the Research Center of U. S. Rubber Co. in Wayne, N. J. He will manage basic and applied research conducted at the Research Center.

After obtaining a doctorate degree in chemistry from the University of Chicago, Dr. Wilson joined the company's general laboratories in 1935 as a research chemist.

Martin E. Roberts has been elected vice president and a director of The Lummus Co. Canada Ltd. He is presently manager there.

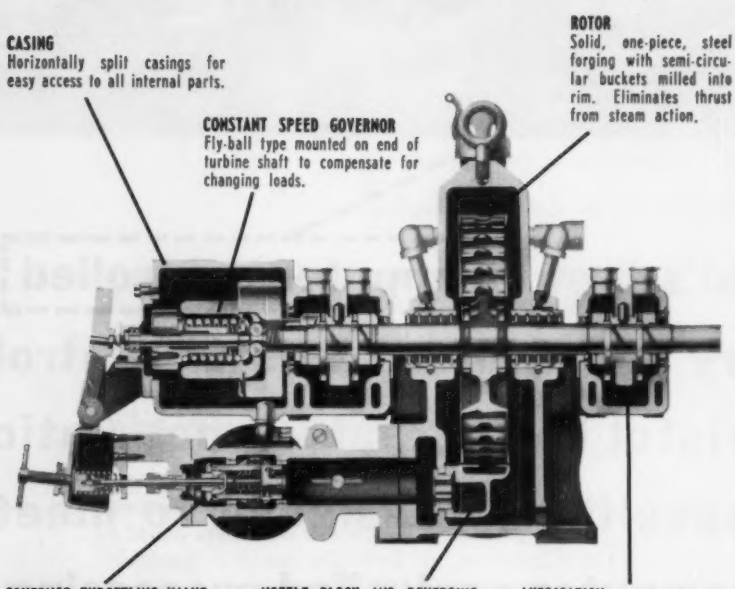
Roberts joined the company in 1946 as a process engineer, and in 1954 was assigned to the London office as a sales engineer. In 1956 he was made manager of the company in Montreal.

David E. Day of Richfield Oil Corp. has been elected president of Iricon Agency Ltd. Iricon Agency represents the five percent interest in the Iranian Consortium held by American Independent

Whiton

PRECISION ENGINEERED STEAM TURBINES

For almost 50 years, Whiton has combined experience, workmanship and **precision engineering** in building high quality, reliable steam turbines for all types of power and drive applications. Whiton horizontal, helical-flow, single stage turbines are available in 8 wheel sizes. Axial-flow, Curtis-blade turbines are also available. Write for complete data on Whiton's horizontal and vertical turbines.


CASING
Horizontally split casings for easy access to all internal parts.
CONSTANT SPEED GOVERNOR
Fly-ball type mounted on end of turbine shaft to compensate for changing loads.
ROTOR
Solid, one-piece, steel forging with semi-circular buckets milled into rim. Eliminates thrust from steam action.
GOVERNOR THROTTLING VALVE
Double-seated, balanced V-ported. Admits steam to assure stability control as load varies.
NOZZLE BLOCK AND REVERSING CHAMBER
One-piece unit. 2, 3, or 4 redirecting buckets as required for maximum efficiency.
LUBRICATION
Water cooled oil ring lubrication.

MAXIMUM OPERATING SPECIFICATIONS

POWER	to 1200 HP
SPEED	to 8500 RPM
STEAM PRESSURE	to 1250 PSIG
STEAM TEMPERATURE	to 1050° FTT

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

After twenty years of standing guard Blaw-Knox Sprinklers save press room... keep paper rolling

When fire flashed across the 90-foot press room of the Pittsburgh *Post-Gazette* thirteen sprinkler heads opened up to smother the flames. Damage was held to a minimum so that the paper didn't miss an issue. So, after twenty years of 'round-the-clock, watchful waiting, this Blaw-Knox Automatic Sprinkler System prevented a disaster.

Whether fire strikes tomorrow, or in the next twenty years, a Blaw-Knox system starts paying off immediately in reduced insurance payments. And when a fire does occur—and there's a seven to one chance it will hit you this year—your custom designed system detects, confines and quenches the blaze . . . keeps you in business.

Blaw-Knox engineers will gladly study your layout, submit an estimate, and explain the lease and deferred payment. No obligation. For details write for Bulletin 2426.

COMPOUND BEND MEETS RIGID TESTS BEFORE SHIPMENT

This 20-foot long, 12-inch diameter seamless steel tubing meets exacting standards for high pressure, high temperature service. Besides outstanding engineering and fabricating facilities, Blaw-Knox provides a digital computer method that speeds your piping stress calculations. Write for details.

UNIQUE INTERNAL SWIVEL PROVIDES TWO-WAY PIPE HANGER CONTROL

This patented action permits movement while hanger case remains vertical. Blaw-Knox offers a complete line of precision-built hangers, supports and vibration eliminators—all furnished as complete units to save engineering time and simplify field assembly. For details write for Catalog 58 today.

BLAW-KNOX

BLAW-KNOX COMPANY
Power Piping and Sprinkler Division
829 Beaver Avenue, Pittsburgh 33, Pennsylvania

For more data on advertised products, use Readers' Service Cards, last page.

Men in the Industry . . .

Oil Co., Atlantic Refining Co., Getty Oil Co., Hancock Oil Co., Richfield Oil Corp., San Jacinto Petroleum Corp., Signal Oil and Gas Co., Standard Oil Co. (Ohio), and Tidewater Oil Co.

Frederick E. Greer has retired after more than 42 years of service with Gulf Oil Corp.

Greer's service as an attorney in the Law department of the Gulf companies began in 1916. He has been in charge of the company's law affairs in Louisiana since 1945.

Russell D. Richardson has been named vice president, finance, of Tidewater Oil Co., retaining his present responsibilities as treasurer and controller. A native of Northfield, Minn., he was educated at Carleton College. He began his career with Tidewater in 1921 as an accounting clerk at the company's Avon refinery in California and became chief refinery accountant six years later.

Richardson

Richardson then served as assistant regional controller and then as controller of the company's Western division. In 1954 he was elected controller of the entire company, and he became treasurer in 1957.

J. F. Adkisson, Jr., formerly wage and salary administrator, Sunray Mid-Continent Oil Co., has been promoted to administrative assistant to the employe relations manager. He will continue to head the wage and salary administration section, and will have general supervision of the Employe Benefits section and the Employment and Personnel Records section.

R. M. Conway has been promoted to chief job analyst in the Wage and Salary Administration section. He was formerly senior job analyst.

Dale D. Stone, formerly personnel representative for the Central Marketing division, has been promoted to supervisor of the Employment and Personnel Records section.

R. C. Frederick has been appointed coordinator for gas and gas liquids by Gulf Oil Corp. He will be responsible for maintaining contact with the operating and staff officers of Gulf and its subsidiaries, throughout the world, in coordinating the company's activities in all matters pertaining to gas and gas liquids. He will report directly to the Senior Officers of the Company.

Robert E. Collins has been appointed chief process engineer of Neches Butane Products Co., Port Neches, Texas. He has been with the company since 1943, having been transferred from the Texas Co. on a leave of absence basis.

Nicholas J. Vaglica succeeds Collins as assistant chief process engineer. He has been with the company since 1943, and has worked in all phases of process engineering.

Walter E. Lobo, formerly director of the Chemical Engineering division of The M. W. Kellogg Co., and later a partner in the consulting firm of Devys & Lobo, has opened his own chemical engineering office in New York.

Richards

Day

David E. Day, vice president of Richfield Oil Corp.'s Manufacturing and Transportation department, will head a separate Petro-Chemical department to direct current activities and any future petrochemical operations the company may undertake.

Functions of the department will include market surveys, process investigations and profitability studies of petrochemicals and methods of production. The department will also represent the company in negotiations on possible joint ventures in the field and will administer present contracts for the sale of aromatics

ONLY the application-engineered

DATAGAGE*

REMOTE MEASUREMENT AND CONTROL SYSTEM

offers these exclusive advantages

NEW ACCURACY
- Only digital system with 1/16" accuracy independent of product gravity.
- Only system satisfactory for use in FLOATING ROOF TANKS.
- Only system to give reliable readings during blending turbulence.

NEW RELIABILITY
- Only system with POWER FLOAT (moving mechanical surface finder) which checks itself automatically.
- Transistors are used instead of short-lived vacuum tubes.
- A true digital system with unlimited-distance, error-safe telemetering.

NEW FLEXIBILITY
- Single dial control for both level and temperature measurement.
- 100 reading point capacity; applicable for alarm devices, valve and pump controls, remote transmission for data processing.
- Application-engineered approach gives you assured performance.

*Trademark registration applied for

Write for complete information, specify Bulletin M-601.

TEXAS INSTRUMENTS
INCORPORATED
INDUSTRIAL INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: HOULAB

147

Tri-State Oil Show

ROBERTS MUNICIPAL STADIUM — OCTOBER 9, 10, 11 and 12, 1958

EVANSVILLE, INDIANA

"The Oil Capitol of the Midwest"

Sixth Annual Tri-State Oil Show:

EXHIBITORS:

Exhibit Space Inside Stadium.
Open Spaces on Paved & Unpaved Surfaces Outside Stadium.
Tented Spaces, Outside Stadium.
Open House—Thursday Evening, Oct. 9, 1958 for Exhibitors and their guests only (Admittance by invitation only—closed to public. Dinner, social hour and entertainment.

CONVOY TO PERMIAN BASIN OIL SHOW—ODESSA, TEXAS, from TRI-STATE OIL SHOW Leaving at daylight, Monday morning, October 13, 1958. Plenty of time to reach Odessa to set up exhibits.

ENTERTAINMENT: Top Television Entertainers for all ages.

ADDRESS INQUIRIES TO *Tri-State Oil Show*

15 Main Street, Evansville, Indiana **Phone HArrison 5-3176**

Hundreds of practical tips on:

• aligning centrifugal pumps • piping for pumps • suction piping • pump priming • sight gage glasses • starting marine pumps • flushing plant piping • freezing • maintenance records • plus WHAT TO DO when no liquid is delivered — when pump loses prime after starting — when pump vibrates too much — when pump loses its suction — when pump consumes too much power — when pump short strokes or piston hits head • and much more

Reduce costs—extend pump life with the practical, step-by-step methods in this expert guide

To help you operate pumping installations efficiently and economically, this handy manual covers every major class and type of pump in use in industrial, municipal, marine, central station, and similar installations. It gives you complete, specific *step-by-step* instructions you need for installing, starting up, routine operation, periodic maintenance, and major overhauling.

PUMP OPERATION and MAINTENANCE

By Tyler G. Hicks

Mechanical Engineer; Instructor in Mechanical Engineering, Cooper Union School of Engineering (Evening Division); formerly Special Projects Editor, *Power*.

310 pages, 6 x 9, 383 illustrations, $9.00

Instructions in this volume are so complete and so exact they enable an engineer or foreman to *thoroughly supervise* the job and a mechanic to *actually perform* the work. In fact, with the help of this book, anyone responsible for pump operation and maintenance will now find it possible to set up a complete program covering the pumping facilities in any plant—from the largest having thousands of pumps to isolated stations having a single, small pump.

Order from:

Book Department
THE GULF PUBLISHING COMPANY
P.O. Box 2608, Houston 1, Texas

HOW TO SOLVE
heat transfer problems

Here is the book to give you a quick view of heat transfer fundamentals and the calculations of applying them in the design of such equipment as feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. Emphasizes basic aspects and immediately useful calculations!

Just Published—3rd Edition

Introduction to HEAT TRANSFER

By **Aubrey I. Brown** and **Salvatore M. Marco**, both of The Ohio State University

Third Edition, 328 *pages*, 6x9, 70 *illus.*, $6.75

Engineers encountering a growing number of problems in this field will appreciate the directness of the treatment. Third edition includes new chapters on fluid flow in the convection process and graphical and numerical methods applied to heat conduction problems.

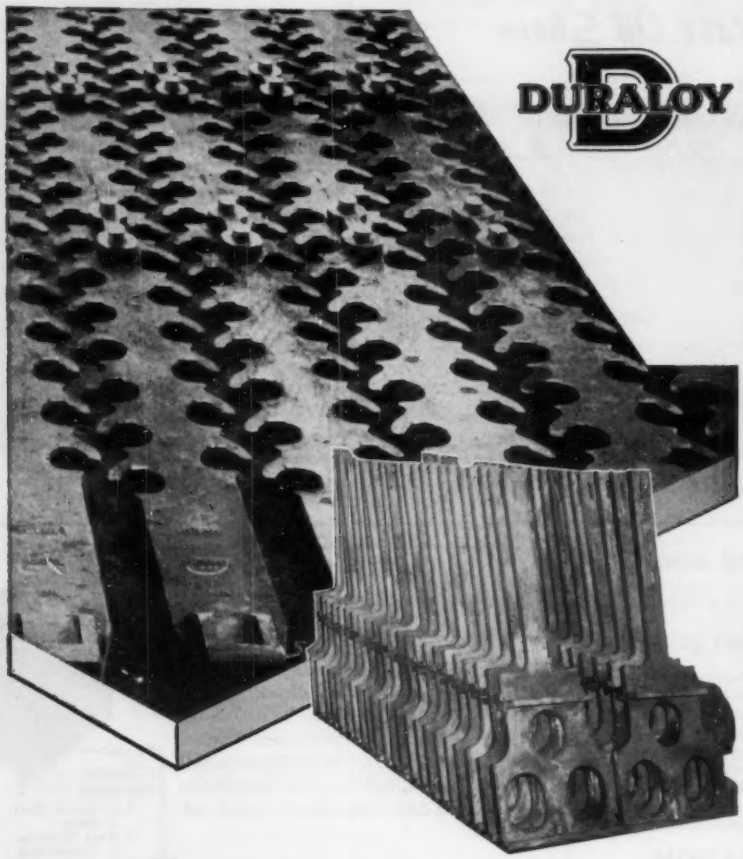
Chapter Headings

1. Modes of Heat Transfer
2. Heat Transfer by Conduction
3. Equations for the Calculation Conduction of Heat Transfer
4. Radiation
5. Fundamental Units and Dimensional Analysis
6. Fluid Flow in the Convection Process
7. Forced Convection
8. Free or Natural Convection
9. Heat Transfer to Boiling Liquids
10. Condensing Vapors
11. Over-all Transfer of Heat
12. Applications of the Principles of Heat Transfer to Design Problems
13. Transient Conduction
14. Graphical and Numerical Methods for Heat-conduction Problems

The Gulf Publishing Company

P. O. Box 2608
Houston 1, Texas

CORROSION RESISTANT
HEAT RESISTANT
Tube Supports



You can't buy Better Tube Supports . . . DURALOY Tube Supports are alloyed to meet individual corrosion and heat requirements. They are alloyed by experienced metallurgists and melted and cast by experienced high-alloy foundrymen, both groups with experience going back some thirty years. Castings are carefully tested in our own laboratories which are completely equipped for metallurgical, chemical and physical testing.

Many refineries have been DURALOY customers for years. Many refineries insist upon DURALOY castings. Whether it's straight production or engineering plus production, we are equipped to do the job. For more information, send for Bulletin No. 3150-G.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Men in the Industry . . .

to chemical companies and market development of these products.

Organization of the new department took effect September 1. **L. M. Richards,** assistant manager of research and development, will take Day's post at the company's Anaheim research center. **C. D. Thurmond,** who has been in charge of market research at the center, will move to the new department.

J. Howard Stark has been named labor relations advisor for Sunray Mid-Continent Oil Co., Tulsa. He will assist in labor relations work for Sunray Mid-Continent, D-X Sunray Oil Co., and Mid-Continent Pipe Line Co. Stark graduated from the University of Texas in 1948.

James E. Stoveken and Sydney Wire have been reassigned by Esso Standard Oil Co. Stoveken will serve as assistant general manager of the company's Marine department. Wire, former secretary of Esso Shipping Co., will replace Stoveken as manager of Esso's Inland Waterways department.

Deane Baker has been elected president of the newly formed Jersey Petroleum Corp. Incorporated under the laws of New Jersey in December, 1957, the company will seek to acquire proven producing oil and gas properties. It maintains principal offices at Lubbock, Texas.

Deane Baker, also elected a director, is the principal officer of Deane Baker & Associates, a Texas petroleum management consulting firm. Other officers include: **W. Doyle Miller,** vice president and director; **Everett J. Canning,** director; **John M. Reed,** geologist and director and **Robert K. Berry,** director.

R. Paul Henry, financial vice-president of Sunray Mid-Continent Oil Co., has been named company treasurer. He joined the company in 1949 as tax counsel for D-X Sunray Oil Co., and was named treasurer there in 1954, financial vice-president in 1955, and vice-president last January.

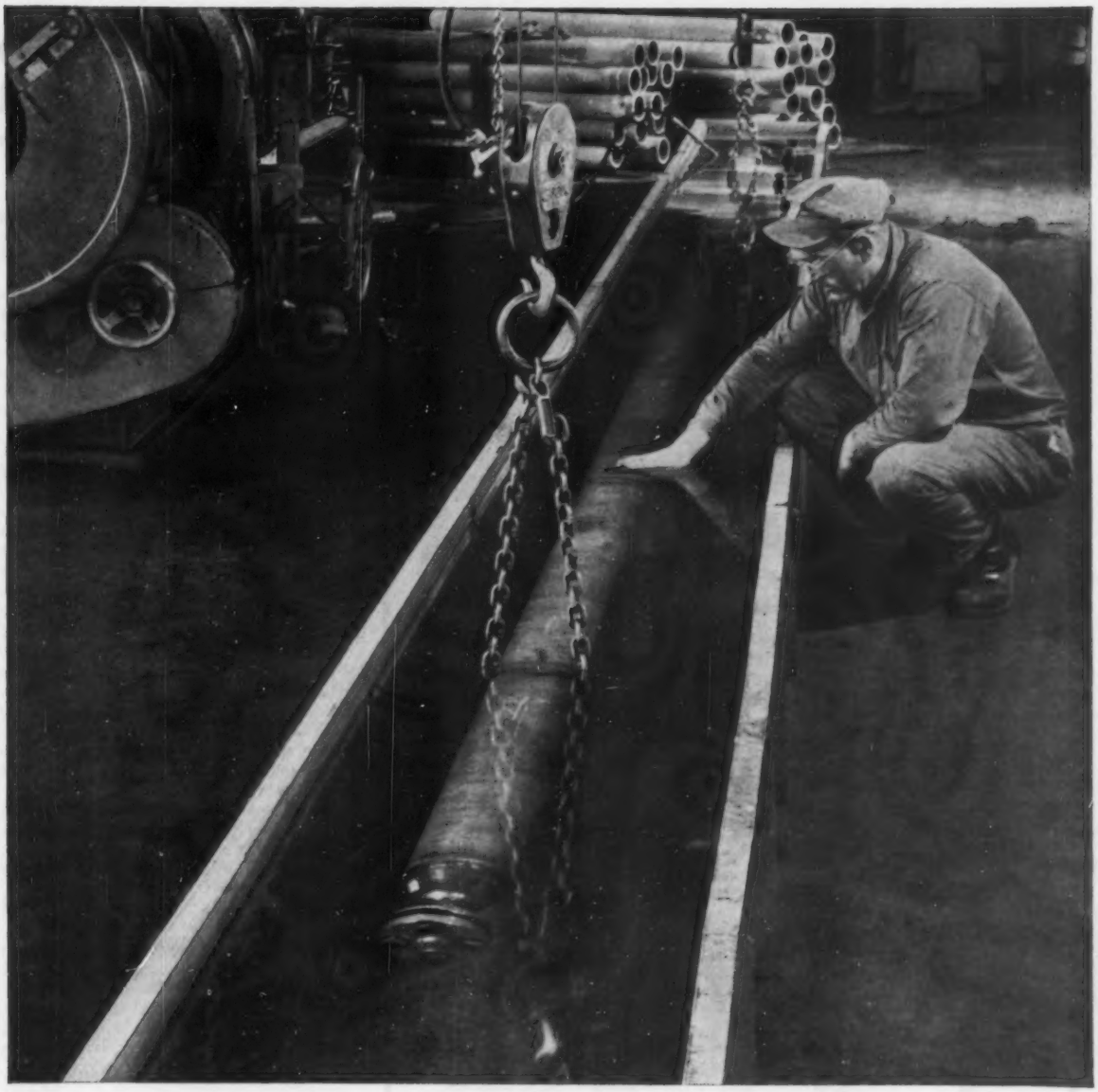
J. C. Alspaugh has been named general foreman of the butadiene and butyl plants at Humble Oil & Refining Co.'s Baytown refinery. **A. T. Robertson** has been named foreman of finishing and storage at the butyl plant.

J. R. Muehlberg, former Technical Services division manager of Esso Export Corp.'s Aviation department, has been transferred to London as aviation advisor for the Eastern Hemisphere. He joined Standard Oil Co. (N. J.) in 1947 following service with the U. S. Air Force.

Donald K. Hedeen has joined the Planning Engineering division of Esso Research and Engineering Co. as head of the general planning and economics section. He joined Esso Research three years ago following eight years with a research company.

Wilbur H. Armacost has won the American Society of Mechanical Engineers Medal, given for distinguished service in engineering and science. He is vice pres-

For more data on advertised products, use Readers' Service Cards, last page.



AIR PRESSURE—Just one of seven leak tests for Thermalloy* Reformer Furnace Tubes

It takes seven thorough inspections to assure you leakproof service . . . and each of our tube assemblies goes through them all. The air inspection shown above tested these tubes under water at 100 psi.

At the beginning of the test series each tube section receives an *air test* and a *hydrostatic test*. Then the tubes are assembled by welding and each weld checked three ways—*Borescope*, *Dychek*, and *X-ray*. We repeat the *hydrostatic and air test* with the complete assemblies. During the test series and at the end of it, there is careful visual inspection by experienced personnel.

A *chemical analysis* assures composition control when the tubes are cast. All this adds up to positive protection against costly leaks.

For reformer furnace tubes that provide leakproof service, specify Thermalloy centrifugally cast tubes—backed by years of casting experience. Call your nearest representative or write: Electro-Alloys Division, American Brake Shoe Company, 9079 Taylor St., Elyria, Ohio. *Reg. U.S. Pat. Off.

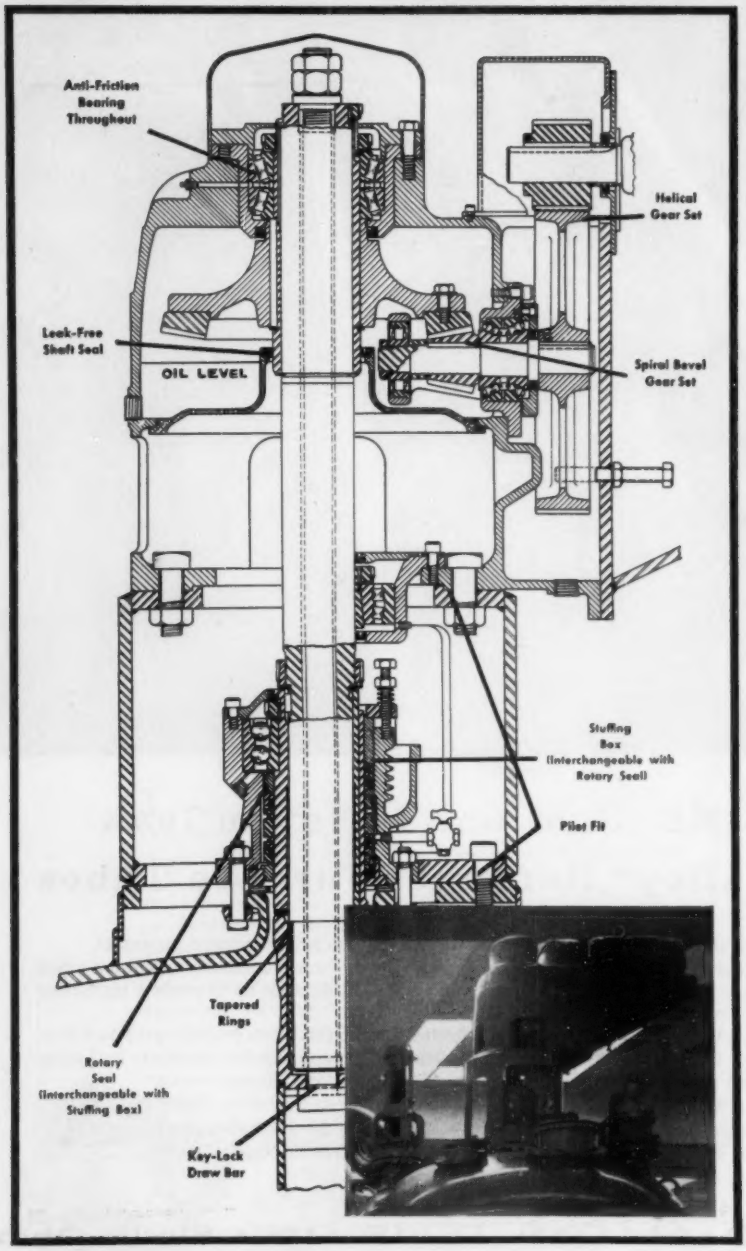
Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

PFAUDLER

Quietly cut maintenance up to 50% with the new BH Agitation Drive



When you first hear the BH Drive running you will know why it consistently cuts maintenance time and cost wherever it is used.

Its soft hum is the sure sign of a machine constructed to run week after week without once faltering or stopping for repairs.

A glance at its blueprint shows the specific areas where it either *eliminates* or *drastically reduces* your maintenance.

Get perfect alignment in minutes. Notice that the pedestal mount is *keyed* to the drive unit with a pilot fit. The pad mount is *machined* level at the factory. Then the drive is made to fit the mount just one way—the right way. You'd have to work some *not* to get perfect alignment every time.

Squeeze more life from a drive. Only two bearing areas support the BH Drive's shaft. This gives much wider bearing spread. Naturally that means less agitator shaft run-out and whip. Seals last longer. Alignment is maintained all the time. The critical agitation speed is increased over previous designs because of greater shaft diameter.

The bearings are all anti-friction types designed in excess of AGMA specifications. Under normal use, they can produce up to 300,000 hours of quiet, wearfree service.

Hardened and lapped spiral bevel gears are *standard*.

Speed up changeovers. You can use either stuffing box or mechanical seal with the BH Drive. Both come as integral assemblies, the Pfaudler-pac, which slip quickly into place. You never remove the drive from its mount to replace a stuffing box or seal.

The new draw bar is key-locked to your agitator. No threads to strip or stick. Tapered rings transmit torque when you draw the bar.

Prevent oil leakage. Besides putting in the usual oil-tight seals, we've recessed the oil reservoir through a well-type construction so that oil level is always *below* the seal. In normal operation oil can never slop over and seep down the shaft.

New motor levelling. Levelling the motor on the BH Drive is easier, too. The new design uses three levelling screws in place of the four jack screws on previous designs.

Three ratings available. You can get the BH Drive rated at 12, 30, or 60 HP at 100 RPM.

For more information on the drive, including complete specifications, send the coupon for our No. 972 Bulletin.

For more data on advertised products, use Readers' Service Cards, last page.

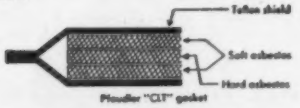
CORROSIONEERING NEWS

B. G. "Joe" Staples talks about Teflon gaskets for corrosive service

Mr. Staples runs our program of Pfaudler Technical Courses for plant maintenance men.

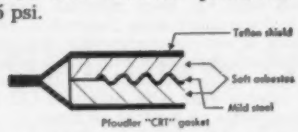
One of his special subjects is "Teflon Gaskets." Thirteen years ago he began devising a gasket for universally corrosion-free service on both glassed-steel and alloy equipment.

Many hundreds of tests later, he and his staff created two separate designs. Both combine Teflon's versatile corrosion resistance with the rigorous physical properties of their fillers.



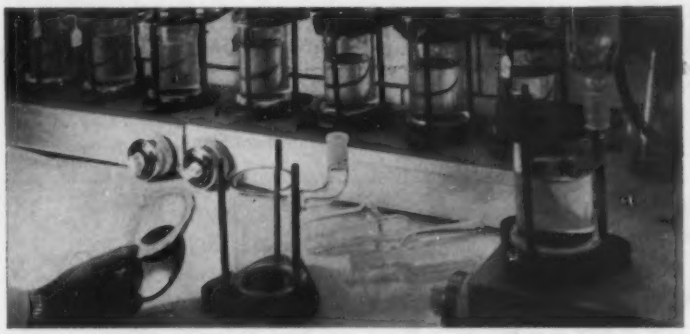
The Teflon envelope on this design licks the corrosion problem. The center core of hard, compressed sheet asbestos makes it rigid and strong. Thin layers of special soft asbestos let you compress the gasket to get a tight seal without danger to glassed-steel flanges.

This design is for service up to 300° F. and internal pressures to 125 psi.



For temperatures up to 500° F. and pressures to 300 psi, we developed this gasket with a thin corrugated mild steel core. This gives the gasket added strength and a springlike action which helps keep the seal tight and reduces the need for shimming.

FREE BULLETIN. To find out more about Teflon gaskets, send the coupon for Bulletin 502.



Test your corrosives FREE in Pfaudler lab

When you're not quite sure how a corrosive material will affect your glassed-steel or speciality alloy process equipment, send a sample to our laboratory.

A staff of expert corrosioneers will run a series of tests which approximate as closely as possible your actual processing conditions.

These men have run thousands of such tests and recognize quickly the telltale marks of corrosion.

They will report quickly, telling you the best material of construction to use and what use-life you can expect from it. Usually quantitive data are obtained in terms of mils per year of corrosion rates.

Run your own tests. If you prefer to run your own tests, we will gladly supply test equipment and procedures. Then do your own evaluation or return the test equipment to us for observation.

Test materials are all free except for the assembly shown in the picture. They include glassed-steel dumbbells which you suspend directly in your process, glassed-steel cups, or disc assembly shown above.

Full range of materials. Naturally glassed steel is our first interest and is usually the best answer to your corrosion problems. However, we also maintain a line of tantalum, titanium, zirconium, various Hastelloys, and various stainless steels for testing. Other metals and alloys on request.

Send for bulletins. The complete testing procedure and list of materials are contained in Bulletin 919. Bulletin 928 discusses the corrosion resistance of Pfaudler acid-alkali-resistant Glassed Steel. Check the coupon for copies.

PETROLEUM EQUIPMENT by PFAUDLER
a division of **PFAUDLER PERMUTIT INC.,**
Dept. PR-68, ROCHESTER 3, NEW YORK

Please send me ☐ Bulletin 972, BH Series Drive ☐ Bulletin 502, Teflon Gaskets ☐ Bulletin 919 Glassed-Steel and Alloy Samples for Tests ☐ Bulletin 928, The Corrosion Resistance of Pfaudler Glassed Steel.

Name.....

Title.....

Company.....

Address.....

City.....Zone.....State.....

See Chemical Engineering Catalog, pp. 1407-1418 for complete Pfaudler line.

For more data on advertised products, use Readers' Service Cards, last page.

Men in the Industry . . .

ident-consultant and chairman of the technical committee at Combustion Engineering, Inc., New York. The medal will be presented to Armacost at the society's annual meeting in New York in December.

Donald G. Mickelwright has joined the Whiting Research laboratories, Standard Oil Co. (Ind.). After attending Case Institute of Technology, Mickelwright obtained a M.S. degree in chemical engineering at the University of Pittsburgh. He will do research on petrochemical processes. Mickelwright was formerly with Blaw-Knox Co.

Bancroft W. Henderson has retired as president of American Synthetic Rubber Corp. **Grant Thomas** will be the new president and a director of the company, and Henderson will continue to be a member of the board.

James K. Logan has been named manager of Catalytic Construction Co.'s Middle Atlantic Area, with headquarters in Philadelphia. He received his B.S. degree in chemical engineering from the University of Missouri.

David T. Searls has been elected general counsel of Gulf Oil Corp. He succeeds **Archie D. Gray,** who was named a senior vice president of Gulf earlier this year. Searls will be responsible for all corporate legal matters.

FROM CONCEPT TO TURNKEY

Surveys, economic analyses, process studies and design, mechanical engineering, procurement, construction supervision and operating assistance are among the services offered by The C. W. Nofsinger Company.

Construction may be handled by a contractor of your choice or by your own personnel. Or, through our affiliate, The Nofsinger-Long Company, we provide both design and construction, ensuring undivided responsibility from concept to completion. Our clients, past and present, will testify to our performance.

"In Engineering, it's the People that count"

THE C. W. NOFSINGER COMPANY

Engineers and Contractors for the Petroleum and Chemical Industries

307 E. 63rd STREET KANSAS CITY 13, MISSOURI

West Coast Representative
A. R. Chandler
609 S. Grand Avenue
Los Angeles 17, California

Gulf Coast Representative
Russell G. Dressler
204 Carolwood Drive
San Antonio, Texas

Richard K. Major has joined the Seymour, Ind. staff of the Whiting Research Laboratories, Standard Oil Co. (Ind.). He will do research on solid propellants.

Mr. Major, who obtained his B.S. and M.S. degrees in chemical engineering at Purdue University, was formerly with the H. O. Canfield Co.

Lewis F. Moody, Jr., has been appointed chief automotive engineer of Socony Mobil Oil Co., Inc. He was formerly senior engineer in the company's Lubricating department. Moody joined the company in 1937 as an automotive engineer in the company's research laboratories at Paulsboro, N. J.

W. J. Birmingham has been appointed patent attorney in the Standard Oil Co. (Ind.) development and patent department. He joined the company in 1948 at the Whiting, Ind., research laboratories.

Birmingham is a graduate of Stevens Institute of Technology, Harvard Business School, and the law school of De Paul University.

Boyd Guthrie, who has been chief of oil-shale mining and engineering for the U. S. Bureau of Mines since 1944 has joined the staff of Socony Mobil Oil Co.'s research and development laboratory, Paulsboro, N. J. He will serve as a consultant on oil recovery techniques. Guthrie spent nearly 30 years with the Bureau of Mines.

Francis S. Friel has been officially nominated for the 1959 presidency of the American Society of Civil Engineers by the Society's board of direction. Friel, who has been vice president since 1956, said he would accept the nomination.

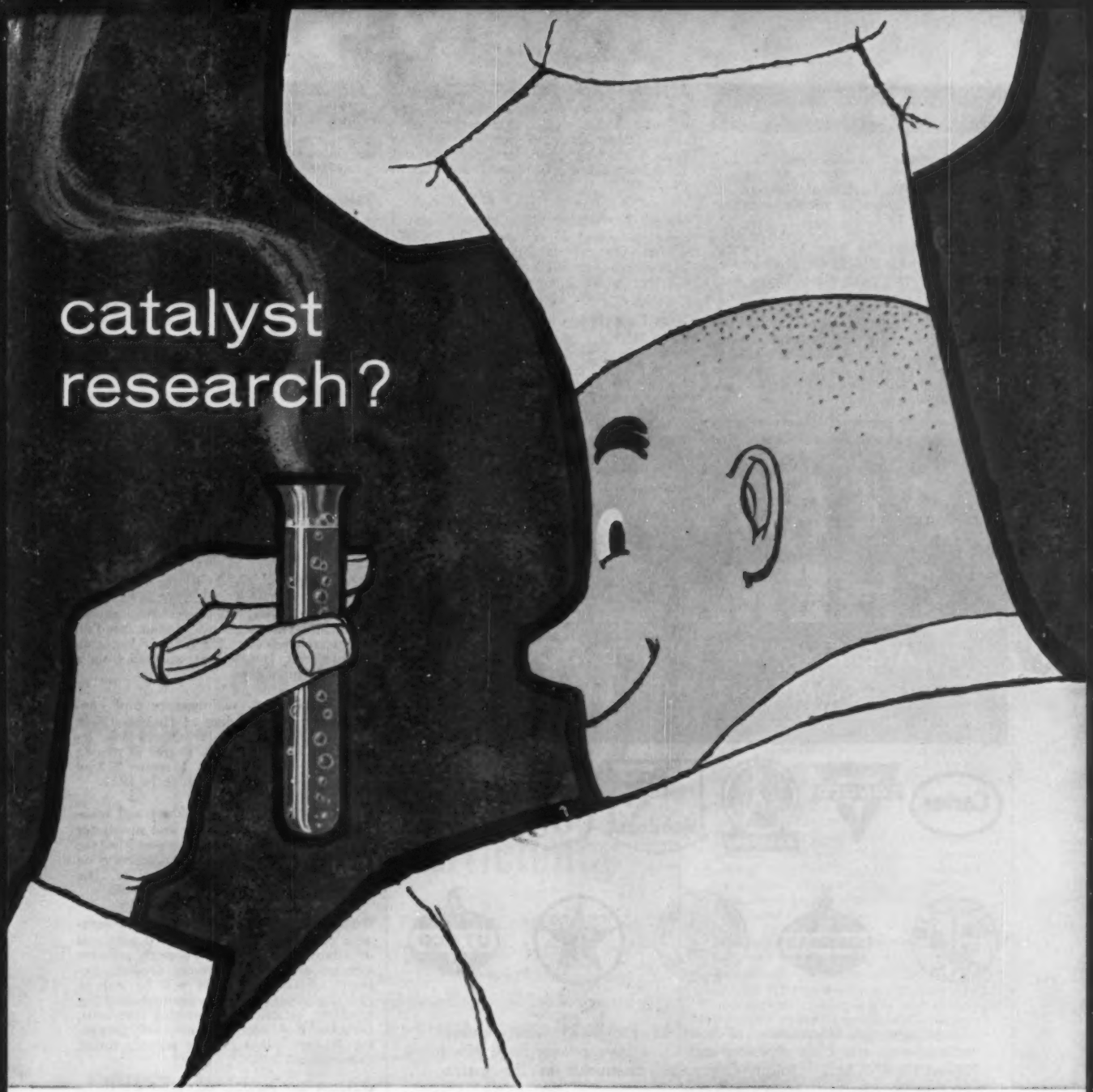
John W. Maloney and **Richard C. McGowan** have been admitted as partners in the firm of Dames & Moore, Soil Mechanics Engineers. Maloney is assigned to the New York office and McGowan is in the General offices of the firm.

Robert C. Wiles has been named assistant controller, and **Terence B. Redmond** manager of financial analysis and planning, in the Controller's department, American Oil Co. Both will have headquarters in the company's general offices in New York.

Julian S. Burrows, manager of Humble Oil & Refining Co.'s marine department for the past 39 years, has retired. He will be succeeded by **Norman B. Avenell** who has been assistant manager of the department since November, 1953. Burrows, a marine engineering and naval architecture graduate of the University of Michigan, joined Humble in December, 1921 after a year with Standard Oil Co. of New Jersey as a naval architect.

Jerome Taylor has been named secretary and general counsel of Goodrich-Gulf Chemicals, Inc. He was assistant city law director for two years at Akron, Ohio, and had practiced law since his graduation from Columbia University in 1931.

M. G. Whitcomb and **W. E. Stevens** have been promoted to senior chemical engineers in the Technical division at Humble Oil & Refining Co.'s Baytown refinery. Whitcomb is following the opera-



Right now at Davison, we're cooking up some new catalysts to help you

Our cooks? Catalyst chemists and engineers with broad experience in research, testing and manufacturing. Our kitchen? The brand-new, superbly-equipped Grace Research Center at Clarksville, Md. Our menu? New and improved petroleum refining catalysts. Our recommendation? Look to Davison for new catalysts to help you. Look to Davison year-in, year-out.

W.R. GRACE & CO.
DAVISON CHEMICAL DIVISION
BALTIMORE 3, MARYLAND

Buy DAVISON—the quality catalyst backed up by experience, research, technical assistance, service!

Men in the Industry . . .

tion of kerosene, gasoline and jet fuel treating facilities, and Stevens is engaged in studies of the fundamental aspects of the reaction kinetics of certain catalytic processes.

Dr. Eric Stern has been named a research chemist for The M. W. Kellogg Co. He was formerly with The Texas Co., Beacon, N. Y.

W. W. Boisture has been named an engineering associate, and **F. J. Buchmann, E. M. Charlet** and **E. A. McCracken** have been named research associates for Esso Standard Oil Co.'s Research laboratories, Baton Rouge.

J. N. Mendenhall, general manager of domestic crude oil production for The Atlantic Refining Co., has retired after almost forty years of service with the firm. A graduate of Baylor University and Yale Law School, he joined Atlantic in 1919.

Lloyd Armstrong has been appointed a vice president of Tidewater Oil Co. He was recently named general manager of Tidewater's Central division, with headquarters in Tulsa.

Sam Bozich has been promoted to foreman of the polymerization unit at the Butyl rubber plant at Humble Oil & Refining Co.'s Baytown refinery. He has a B.S. degree in chemical engineering from Notre Dame University.

PENNSALT CHEMICALS

ARE KNOWN BY THE GOOD COMPANY THEY KEEP

Carter · CONOCO · MARATHON · Mobilgas · Phillips 66 · SHELL

SINCLAIR OILS · STANDARD · STANDARD OIL COMPANY OF CALIFORNIA · TEXACO · UTOCO

These are the trademarks of some of the many widely-known refineries in the United States and Canada who long have relied upon PENNSALT Quality-Controlled chemicals in the manufacture of fine petroleum products.

QUALITY-CONTROLLED CHEMICALS FOR BETTER REFINERY PRODUCTS

Pennsalt CAUSTIC SODA • Pennsalt LIQUID CHLORINE
Pennsalt ANHYDROUS AMMONIA
Pennsalt ANHYDROUS HYDROFLUORIC ACID

PENNSALT OF WASHINGTON DIVISION
PENNSALT CHEMICALS CORPORATION
TACOMA, WASHINGTON

OFFICES AND TELEPHONES

Tacoma, Wash.—MArket 7-9101 Los Angeles, Calif.—LUdlow 7-6244
Menlo Park, Calif.—DAvenport 6-8290 Portland, Ore.—CApitol 8-7655
Philadelphia, Pa.—LOcust 4-4700 Vancouver, B.C.—CRestwood 8-1412

Pennsalt Chemicals ESTABLISHED 1850

J. M. B. Howard, who joined Standard Oil Co. (N. J.) as a deck officer on a tanker in 1933, has been granted leave of absence as deputy coordinator of transportation to serve as president of a new company affiliate, Esso Tankers, Inc.

Rawleigh Warner, Jr., manager of Socony Mobil Oil Co., Inc.'s Economics department, has been appointed manager of the department of Middle East affairs, succeeding **Arnold Stebinger,** who assumed a special assignment with the company's overseas operations.

Thomas W. Phelps, assistant to the chairman of the board of directors since 1949, will be manager of the economics department, while **Paul Wollstadt,** with the company since 1951, succeeds Phelps.

Dr. Samuel M. Darling has been promoted to research supervisor in the Chemical and Physical Research devision of The Standard Oil Co. (Ohio) in Cleveland.

Dr. Darling's activities have dealt particularly with additives for fuels and lubricants, and he is also responsible for the work of the division's engine laboratory. He has M.S. and Ph.D. degrees in organic chemistry from Western Reserve University.

Dr. Bernard S. Friedman will receive the 1958 Honor Scroll Award of the Chicago chapter, American Institute of Chemists at a testimonial dinner this fall. A research associate for Sinclair Research Laboratories, Inc., he was selected from a list of 10 nominees.

W. H. Reber, maintenance and construction superintendent at Humble Oil & Refining Co.'s Baytown refinery has retired. He received a B.S. degree in mining and civil engineering at Missouri School of Mines, and joined Humble in 1924.

P. M. Broach, vice-president and manager of crude oil purchases and supply for Suntide Refining Co., has moved to the company's Corpus Christi refinery on Nueces Bay, where his office will be. The company's Tulsa office will be closed.

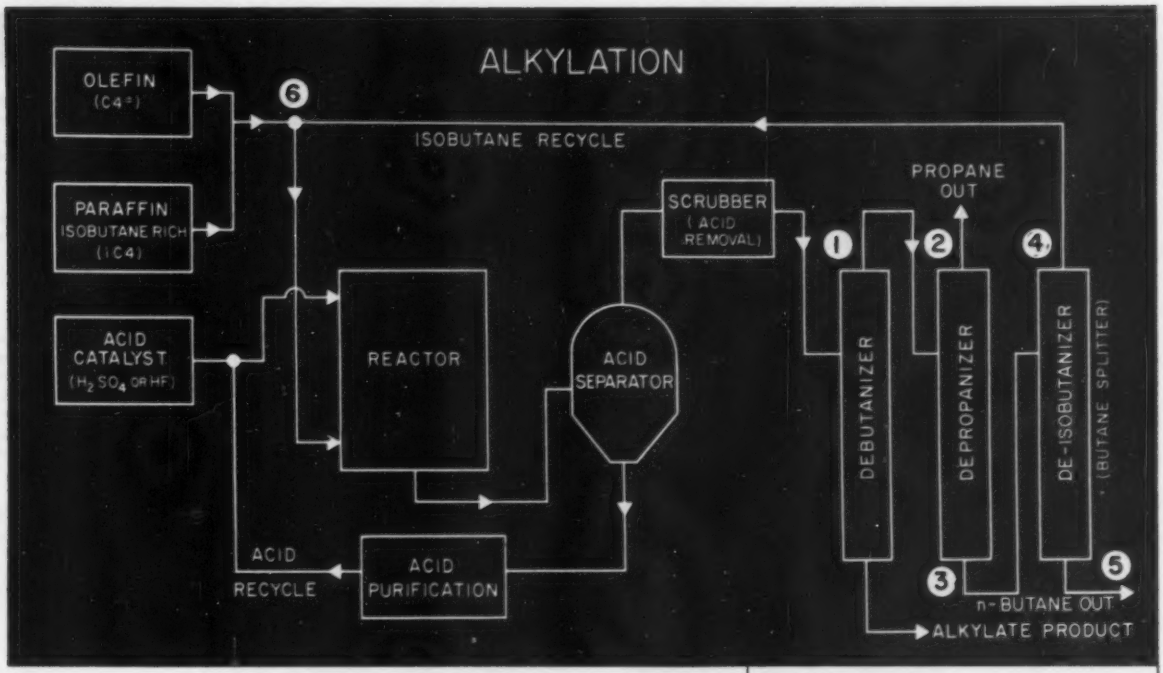
Robert D. Bent has been named manager of the Technical Service department of Atlantic Refining Co. Formerly assistant director of the Development division, Research department, Bent will be responsible for improving processes and resulting products, establishing operating standards, reducing raw material costs, and preparing forward plans for the manufacturing department.

Robert R. Chase has been promoted from assistant superintendent to superintendent at The Texas Co.'s El Paso refinery. He graduated from the University of Arkansas in 1935 with a B.S. degree in chemical engineering, received his M.S. degree from M. I. T. in 1939, and joined The Texas Co. in 1941.

D. E. Bown has been promoted to senior research chemist, and **W. G. Domask** and **L. T. Yule** were named senior research chemical engineers in the Research and Development division at Humble Oil & Refining Co.'s Baytown refinery.

J. F. McCanne and **A. B. Hiser,** have been promoted in the Technical department of Magnolia Petroleum Co.'s Beaumont refinery. McCanne will be a senior technologist assigned duties relating to

For more data on advertised products, use Readers' Service Cards, last page.



Perkin-Elmer® Process Vapor Fractometer Gives New Control Over Alkylation Efficiency

A new process gas chromatography instrument is changing the economics of alkylation. In the squeeze between feed purity and percent valuable component recovery, this low cost* instrument is giving refiners higher operating efficiency, closer adherence to specs. Savings up to $400,000 per year have been reported with this instrument — the Perkin-Elmer Model 184 Process Vapor Fractometer.

The Model 184 performs multi-component analyses of process streams *automatically* every fifteen minutes. The instrument will handle gases and low molecular weight liquids, including hydrocarbon mixtures of both paraffins and olefins.

For more information on how the P-E Model 184 Process Vapor Fractometer can give you better control over your process efficiency, write for "Automatic Plant Stream Analysis." We're at 880 Main Avenue, Norwalk, Conn.

*Price $4,650, subject to change without notice.

How the P-E Model 184 Monitors Typical Alkylation Unit

Sample Point 1 — Debutanizer Overhead:
Efficient operation of the debutanizer calls for just a few percent isopentane. The Model 184 analyzes for isopentane coming overhead; permits the n-C_4—i-C_5 cut to be made with optimum efficiency.

Sample Points 2 & 3 — Depropanizer Overhead and Bottoms:
The Model 184 monitors the depropanizer overhead, which should be high in propane content, with isobutane held at a low level for greatest efficiency. Depropanizer bottoms are checked for high isobutane content, low propane content.

Sample Points 4 & 5 — Deisobutanizer Overhead and Bottoms:
Control of the deisobutanizer is extremely important to the economics of the alkylation process. The overhead should contain almost pure isobutane with a few percent propane and normal butane. Bottoms should have high normal butane with isobutane losses held to a minimum. These two analyses are critical to the operation of the alkylation process. **They are the analyses most often performed by Model 184 instruments.**

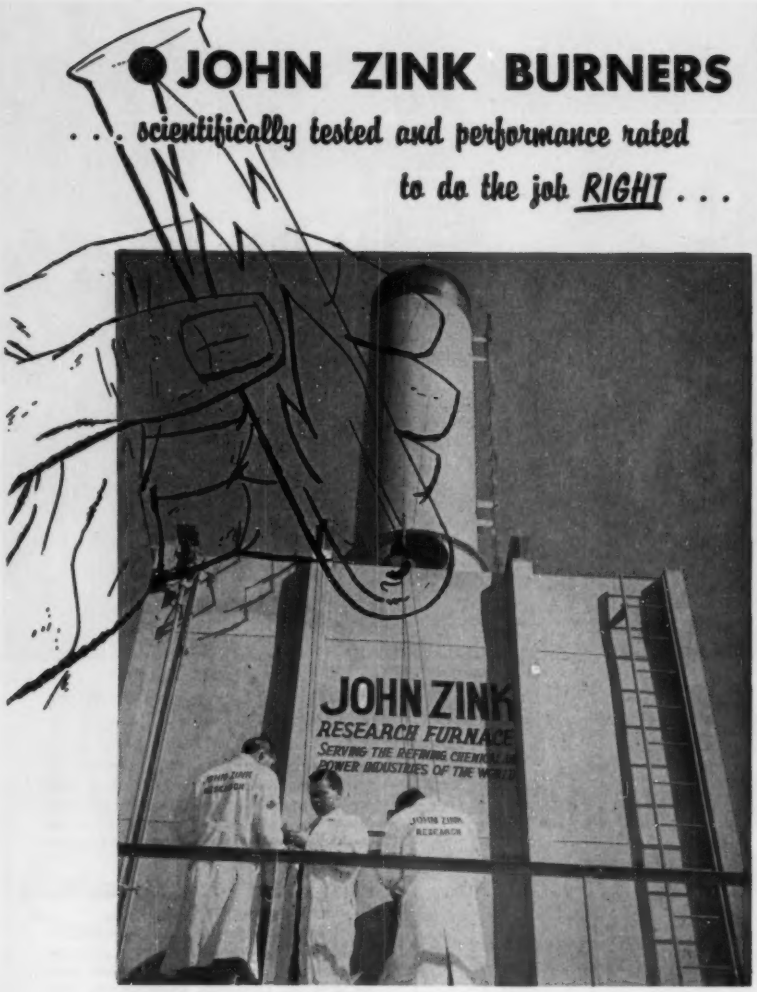
Sample Point 6 — Reactor Feed:
Monitoring the isobutane-C_4-olefin feed ratio is becoming increasingly common. A change in olefin-paraffin ratio can have a detrimental effect on the reaction. The Model 184 performs this check automatically every 30 minutes. The other analyses indicated are performed on a 15 minute cycle with the Model 184.

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

JOHN ZINK BURNERS

. . . scientifically tested and performance rated to do the job RIGHT . . .



This research furnace affords an ideal proving ground for design changes in standard lines of burners, as well as enabling the John Zink Company to find *workable* solutions to new problems. In this way the John Zink Company can offer you special burners for your individual application . . . burners that have been *performance tested* before they reach your job site.

→ *The facilities of the John Zink research furnace are available to industry.*

WE MAKE HEAT . . . AROUND THE WORLD

If you have a specialized industrial burner problem . . . JOHN ZINK has the answer . . .

JOHN ZINK COMPANY

4401 SOUTH PEORIA TULSA 5, OKLAHOMA

Men in the Industry . . .

processing butanes, propanes, gasolines, and other light products. Hiser is responsible for studies relating to operation of lubricating oil units and to blending and shipping of lubricating oil products.

Jack A. Horner has been named secretary of Shell Chemical Corp. He is vice president in charge of the Licensing division, and will retain his posts with Shell Oil and Shell Development.

H. E. Widdell, president of Arthur G. McKee & Co., has been elected a director of Raymond International Inc. The election reflects a new McKee-Raymond working association for the designing, engineering, and construction of new petroleum refineries and chemical plants for overseas customers.

Wheeler G. Lovell has been promoted to research advisor in charge of research planning on the general manager's staff, Ethyl Corp., Detroit research laboratories. He will be responsible for formulating and developing new research projects. **Dr. W. B. Ligett** will succeed Lovell.

Charles W. Cox will head a new Daniel Construction Co. office in New York City. He was formerly with American Viscose Corp. and The Chemstrand Corp.

Philip E. Darling has been named director of professional recruiting for the Manufacturing and Research and Development departments of American Oil Co. He will be responsible for procurement of technical and professional personnel for the company. The former assistant manager of engineering joined American Oil in 1934. He was named chief draftsman, Engineering department, in 1936, and was promoted to chief design engineer, and, later, to chief refinery engineer.

Darling

Darling is a graduate of M.I.T., where he received a B.S. degree in chemical engineering in 1927.

M. W. Johnson, president of Esso Standard do Brasil, Inc., has been appointed deputy coordinator of marketing for Standard Oil Co. (N. J.), effective November 1. He will be succeeded October 1 by **C. J. Griffin,** now vice president of the Brazilian affiliate.

Richard E. Chislett has been appointed secretary-treasurer of the National Constructors Association. He was formerly chief of the Employer Relations section, International Labour Office, Geneva, Switzerland. He is a graduate of Princeton University.

Dr. Arthur S. Gow, Jr., has been named a research chemist for The M. W. Kellogg Co. Formerly with U. S. Steel Co., he will work in exploratory research.

For more data on advertised products, use Readers' Service Cards, last page.

"A far greater use of energy throughout the world is absolutely necessary if the living standards of millions of people are to be raised substantially. Furthermore, it seems likely that a large part of this energy is going to come from petroleum. I do not underestimate the potentialities of coal and the unexplored possibilities of the atom. But it does seem certain that higher standards of living and the security of the free world will depend upon energy from oil for the foreseeable future."

Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

ESSO

STANDARD OIL COMPANY (NEW JERSEY)
AND AFFILIATED COMPANIES

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Brown

Robert E. Brown will head a new sales office for Kaiser Steel Corp. in Houston, Texas. The new office will be in the Esperson Building in downtown Houston. Service will be increased to the Texas and Gulf Coast markets, formerly served from the company's Tulsa sales office.

Brown has been with Kaiser's sales department for six years, and was in the Tulsa office before being named Houston sales representative. Before joining Kaiser Steel, he was with Carpenter Paper Co., Denver. He is a graduate of Miami (Ohio) University.

Flori

Robert D. Flori, president of The Flori Pipe Co. and Houston Pipe & Steel, Inc., has been elected to the national board of directors of the Young Presidents' Organization, Inc., for a two-year term. Elections were held at the organization's recent annual meeting in Honolulu, T.H.

The Young Presidents' Organization is an international group with 1,500 members in the U. S., Canada and other countries. Last year Flori served as chairman of the National Audit Committee. He has been a member of the Y. P. O. for six years.

Hendryx

John Hendryx has been promoted from product manager to manager of compressor sales by The J. B. Beaird Co. The move came as part of a realignment of functions in general products sales.

Hendryx has been with Beaird since 1951, serving as both design and sales engineer, for Beaird-Ingersoll-Rand packaged compressor plants during his tenure. Previously, he was with Texas Eastern Transmission Corp., Gulf Oil Corp., and Magnolia Pipe Line Co. Hendryx studied mechanical engineering at Texas A & M College.

Blickensderfer

Michael G. Blickensderfer has been appointed a sales engineer for Acheson Colloids Co., Port Huron, Mich., a division of Acheson Industries, Inc. He will join Acheson's Cleveland office, serving the Northern Ohio territory.

Blickensderfer joined Acheson Colloids after nearly three years in sales with the Glidden Co., Cleveland. He is a graduate of Wittenberg College where he received a B.A. degree.

Bootz

Charles R. Bootz has been named manager of Black, Sivalls & Bryson, Inc.'s Controls division, Tulsa. He will be responsible to the executive vice president for all phases of the division's operations.

Bootz has been with the company almost two years as manager of its nuclear project at Tulsa. Before that he was director of laboratories of Rand Development Corp., Cleveland. He has a B.S. degree in engineering from the U. S. Military Academy, and M.S. degrees in chemical engineering and metallurgy from the University of Michigan.

Balentine

William H. Balentine, manager of Thomas A. Edison Industries' Instrument division, has been appointed a vice president of the company. He will continue as manager of the division, a post he has held since August, 1957.

Balentine graduated from Newark College of Engineering with a degree in electrical engineering in 1942, has been associated with Edison for 17 years. He served with the U. S. Navy in World War II and the Korean war, and is now an instructor at the Naval Reserve Officers School, Elizabeth, N. J.

Rademacher

R. W. Rademacher, formerly manager of plant storage, has been promoted to manager of The J. B. Beaird Co., Inc.'s Eastern division and will be in charge of the New York office. Rademacher has been closely associated with Beaird's pressure vessel program since he became associated with the company in 1952 and has served as manager of plant storage and contract sales for two years. Before joining Beaird, he was a sales engineer with United Petroleum Gas Co. and Skelly Oil Co., located in the Minneapolis office of both companies.

McLellan

George W. McLellan, a research physicist for Corning Glass Works, has been named coordinator of technical information service in the Company's Public Affairs division.

With the company's Research and Development division since 1940, McLellan has been supervisor of the Works Control laboratory, manager of the General Product Development department, and most recently as staff engineer. He graduated from the University of Maine in 1937 and is a member of the Society of Glass Technology and the American Physical Society.

Pope

Gerald Pope, formerly assistant general sales manager of The J. B. Beaird Co., has advanced to general sales manager. He has experience at both field and executive levels.

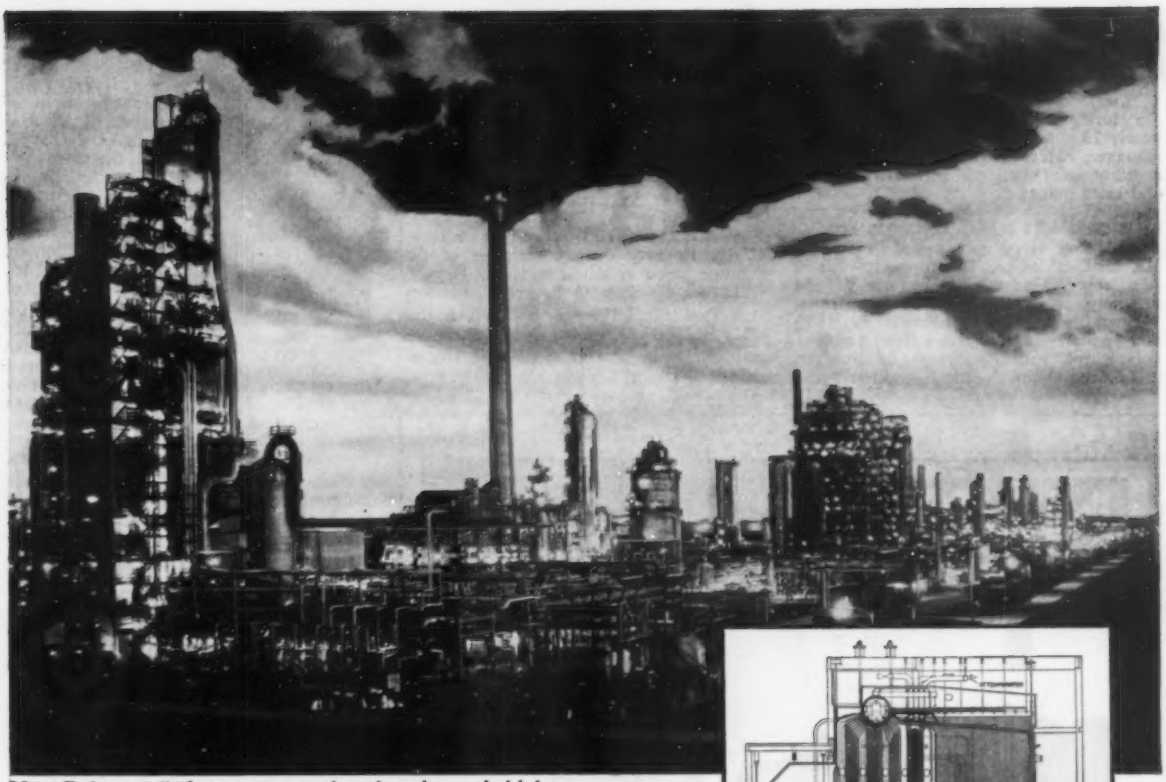
Pope joined Beaird 11 years ago as a sales engineer in the Shreveport office. He served as product manager of contract and LP-Gas equipment sales, later moving to Houston as district sales manager. Before joining Beaird, he served five years with Texas Power & Light Co. in Dallas.

Finuf

Melvin A. Finuf, manager of sales since May, 1957 has been named to the staff of the executive vice president of The J. B. Beaird Co., Inc., as marketing assistant.

Climaxing 23 years of experience in sales, engineering and production at Beaird, Finuf will perform a key staff role in the planning and execution of the company's long range program of market expansion.

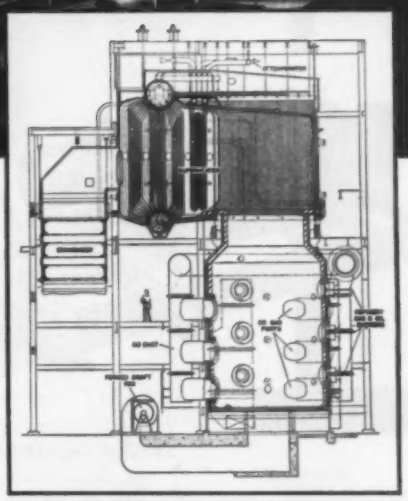
Joining Beaird in 1935, Finuf moved up in the production department successively to plant engineer, superintendent of the machine shop and superintendent of



New Delaware Refinery, representing the advanced thinking of refinery engineers and technologists, can process 130,000 barrels of crude oil daily to manufacture products of unprecedented purity and power.

B&W CO Boiler Turns Waste Into Profit for Tidewater Oil Company

Gives 2-Way Bonus: Fuel Saving Sufficient To Drive Entire Cracking Unit *Plus* Help in Eliminating Air Pollution.



B&W CO Boiler is designed to generate 425,000 lb of steam at 600 lb pressure and 750 F degrees at the superheater outlet, utilizes 552,000 lb per hour of coker exhaust gases entering the boiler at a temperature of 1125 F degrees.

The Tidewater Oil Company, at its ultra-modern 130,000 barrel-per-day Delaware Refinery, installed a B&W Carbon Monoxide Boiler that is the largest of its kind in operation anywhere in the world. The exhaust gases from the fluid coker are recovered and used by the CO boiler to produce high pressure, high temperature steam for power and process requirements. The savings made possible by efficiently burning these gases which would otherwise be wasted, are expected to pay for the boiler within 3 to 4 years.

In addition to fuel savings, B&W CO Boilers also contribute to better community relations by helping to eliminate pollutants released to the atmosphere. This is accomplished by burning out the entrained coke dust and other combustible products discharged from the fluid coker.

For efficient and economical application in new or existing fluid coking and catalytic cracking units, B&W CO Boilers warrant careful consideration. For further information, write for Bulletin G-87, The Babcock & Wilcox Company, 161 E. 42nd Street, New York 17, N. Y.

CO-100

BABCOCK & WILCOX

BOILER DIVISION

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

the forge plant. Transferring to sales nearly 15 years ago as tank divisional sales manager, Finuf has subsequently served as assistant sales manager and assistant general sales manager.

ALLIS-CHALMERS MANUFACTURING CO. has named **Y. S. Hogg** manager of its Tampa, Fla. district office. He formerly was a sales representative working out of the company's New Orleans district office.

Hogg joined Allis-Chalmers in 1949 shortly after his graduation from Alabama Polytechnic Institute, where he received a B.S. degree in electrical engineering.

BABCOCK & WILCOX CORP.'s Boiler division has named **Harold D. Kenney** comptroller. He began with B&W in 1953 as assistant works accountant in Akron, Ohio, and joined the comptroller's staff in New York four years later.

A member of the National Association of Accountants, Kenney received an A.B. degree from Valparaiso University in 1941.

PARKER-HANNIFIN CORP. has named **C. Q. Hagerty** district manager of distributor sales in southern Calif. Hagerty will work closely with Parker distributors.

A Parker employee since 1937, he has filled various jobs, most recently as a plant manager with Parker Seal Co. He attended Western Reserve University.

MECO Integrated SERVICE

skid-mounted

. . . with proportional sampler

Unit automatically shuts down after allowable has been flowed, with volume corrected to 60°F and registered on counter and/or ticket.

MECO sampler stores sample at line pressure.

Air and non-condensible gases are automatically separated from liquid and vented. Metering of gases is prevented.

Unit includes line-size strainer • SMITH line-size deaerator • float-operated pilot and safety shut-down valve • MECO proportional sampler • A. O. Smith positive displacement liquid meter • SMITH set stop valve.

MECO MAINTENANCE Mechanical CORPORATION
SUBSIDIARY OF
P. O. BOX 2637 3741 CLINTON DRIVE
PHONE CA 2-2351 HOUSTON 20, TEXAS

CONSOLIDATED ELECTRODYNAMICS CORP.'s International department will have jurisdiction over export sales activities and foreign operations of Consolidated Electrodynamics Corp., GmbH, the company's subsidiary in Frankfurt-Main, Germany. **Wallace E. Kirby** has been named manager of the export office, and **Rodney W. Meyer**, director of the new department.

Meyer

Meyer, manager of export sales since June, 1956, joined the company in 1955 as staff assistant to the director of sales. He has a B.S. degree in mechanical engineering from the University of Texas and is a registered professional engineer in Texas and Colorado.

Kirby, a graduate of California State Polytechnic College with a B.S. degree in mechanical and electrical engineering, joined CEC in 1951 as an installation engineer. He has been a field engineer in export sales since 1956.

ALLIS-CHALMERS MANUFACTURING CO. has appointed **E. T. Cuddeback** manager, General Products division sales, Southeast region. He will maintain his headquarters in the firm's regional office in Atlanta.

Cuddeback is responsible for the promotion, planning and coordination of sales through the district offices.

He is a 1930 graduate of Syracuse University where he received a B.S. degree in administrative engineering. He joined Allis-Chalmers in 1946 and was assigned as a sales representative in the Atlanta district office. In 1948 he became manager of the Tampa district office and has been manager of the Florida district since 1952.

Hamilton

Lorenz

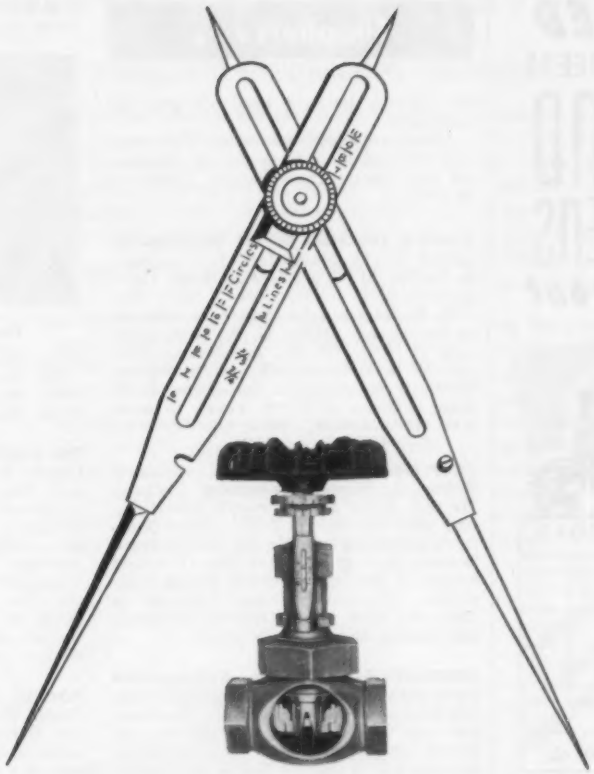
JONES & LAUGHLIN SUPPLY DIVISION has appointed **V. A. Hamilton**, salesman at Pleasanton, Texas, to district sales manager of the Panhandle district with headquarters at Amarillo.

O. M. Lorenz, assistant district sales manager of the Illinois-Kentucky District is promoted to district sales manager of that district with headquarters at Olney, Ill.

Hamilton joined J&L Supply as a Storeman at Luling, Texas in 1937, while Lorenz started with the company at Salem, Ill., in 1939.

BLAW-KNOX CO.'s Buflovak Equipment division has appointed **Wilbert E. Luley** a sales engineer in the company's Chicago office. He joined Blaw-Knox in 1951 as chief project engineer, and in 1954 was promoted to principal autoclave engineer,

For more data on advertised products, use Readers' Service Cards, last page.



PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel —you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.

Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.

MANNING MAXWELL & MOORE INC. TRADE MARK

HI-58

HANCOCK "FLOCONTROL" VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

ENGINEERED
CRAFTSMANSHIP KEEPS
CLEVELAND WIRE SCREENS
'way out in front

JOB CONTROL RECORD		
TIGHTNESS OF WEAVE		
ACCURACY OF CRIMP		
QUALITY OF METAL		
UNIFORMITY OF WEAVE		
WIRE THICKNESS		
SPECIFIED SIZE		
FLEXIBILITY		
DURABILITY		

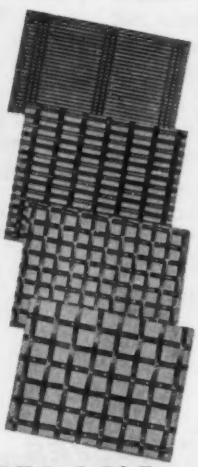
TESTED AND APPROVED BY _____

THE CLEVELAND WIRE CLOTH & MFG. CO.

Successful processing depends on the ability of the wire screens to resist corrosion, abrasion and blinding. The accuracy of openings and proper selection of metals, woven to exact job specifications are controlled by expert craftsmanship and engineering supervision.

Filter segments and strainer elements can be fabricated to your individual job requirements. A wide range of weaves in all commercial metals and alloys such as stainless steel, monel, silver and copper are available.

We maintain a complete sample service department to take the guess work out of job specifications. Complete and descriptive bulletin files are available. Write or phone Diamond 1-1832.



Reference:
Purchasing Directory
Thomas' Register
Conover-Mast
MacRae's Blue Book

Petroleum Refiner Catolog

The CLEVELAND WIRE CLOTH & MFG. Co.
3571 E. 78th STREET - CLEVELAND 5, OHIO

Suppliers . . .

the position he held until his new appointment.

Luley attended Valparaiso University and received his B.S. degree in mechanical engineering from Purdue University in 1943.

JONES & LAUGHLIN SUPPLY DIVISION has named **W. C. Blackledge,** store manager at Laurel, Miss., a salesman there. Other appointments:

H. E. Reeves, sales trainee, to salesman at Brookhaven, Miss.; **G. R. Cain,** storeman at Hobbs, N. M., to salesman, Kermit; **D. R. Williams,** salesman, at Snyder, Texas, to salesman at Tulsa; and **P. V. Ray,** salesman at Alice, Texas, to salesman at Pleasanton, Texas.

COOPER-BESSEMER CORP. has appointed **Robert S. Warren** advertising manager. He will direct the company's advertising and sales promotion. With Cooper-Bessemer's marketing activities for over 14 years, Warren is a graduate of the Cleveland School of Art and attended Miami University. He joined Cooper-Bessemer in 1945 and later joined Griswold-Eshleman Advertising Agency at Cleveland.

MINNEAPOLIS-HONEYWELL REGULATOR CO.'s expansion of its Datamatic division has resulted in the opening of a Washington sales office. **Robert F. Anderson,** assistant manager of southeastern sales, is in charge, with **Fillmore Dobbs** as assistant.

WALWORTH CO. has appointed **Dr. J. F. Dunn** as assistant director of research.

Dunn

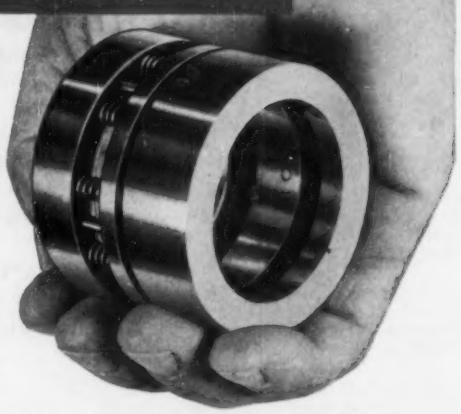
Prior to joining Walworth Co. in 1957 as a research engineer, Dr. Dunn was a project leader in the Dynamic Analysis and Control laboratory at the Massachusetts Institute of Technology. His work at the laboratory included studies of servo-valve actuators, control systems, and oil-hydraulic and pneumatic servo-valves for missile and other high performance applications.

Dr. Dunn received a B.S. degree in 1951, his M.S. degree in 1953 and his Ph.D. degree in 1957 from M.I.T.

THE COOPER-BESSEMER CORP. has acquired Creole Engineering, Inc., Houston, as a new wholly owned manufacturing and engineering subsidiary. The Houston operation is to be headed by **T. E. Kraner** as president. He was formerly district manager of Cooper-Bessemer's Caracas, Venezuela, office, and more recently of the New Orleans office. In both territories he was active for several years in the sale and application of both land and offshore power and compressor equipment.

HOOKER CHEMICAL CORP. has elected **Frank W. Dennis, Dr. Earl L. Whitford** and **Robert E. Wilkin** senior vice presidents, naming these and several other officers to a newly-created management com-

The Answer to Your *SEALING PROBLEMS* in the Palm of Your Hand



DURA SEAL
ROTATES WITH THE SHAFT

. . . an engineered rotary mechanical seal that is made to meet YOUR SPECIFIC SEALING NEED using selected alloys, carbons and ceramics.

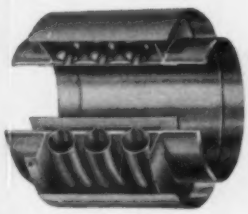
In general, Dura Seals can be installed on new or existing equipment—no sleeves or special machining necessary.

Write Today FOR DETAILS — ASK FOR BULLETIN NO. 480-PR

Send your sealing problems to us for free counsel

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

NEW ZALLEA HyPTor* TOROIDAL EXPANSION JOINT



HyPTor corrugations have a circular or toroidal cross section which provides a lower operating stress at any given pressure than any other corrugation shape.

For unequalled endurance at pressure and temperature extremes

This unique toroidal expansion joint with thin-walled bellows is setting new performance and durability records in high pressure, high temperature service. It was developed to meet the severest operating conditions without sacrificing long life.

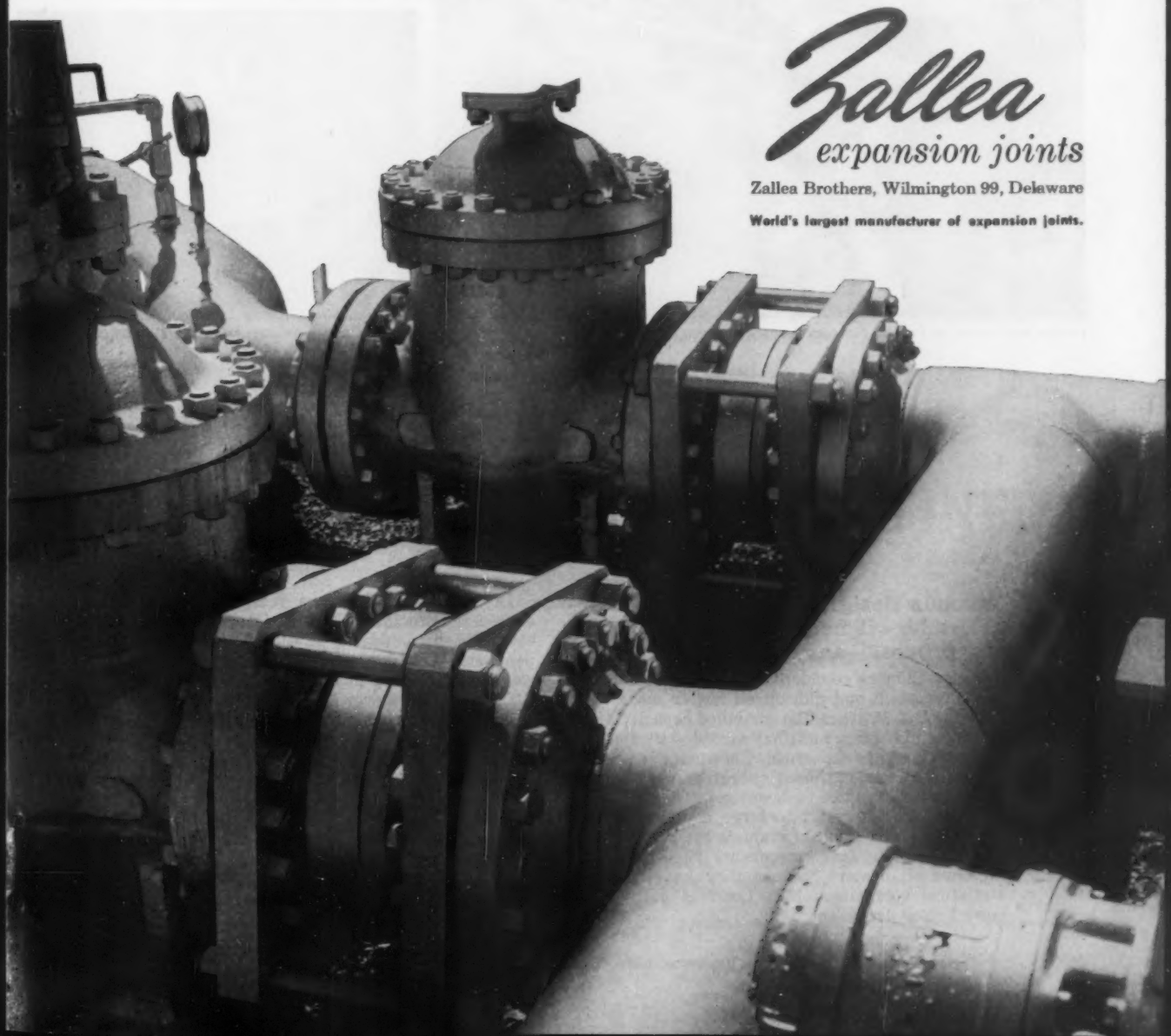
Minimum stress at high pressures is one advantage of the Zallea HyPTor. This is due to the thin-walled bellows and toroidal corrugations. Thin walls develop lowest flexing stress. The toroidal cross section assures lower operating stress at any pressure.

Superior performance at high temperatures. The toroidal corrugation of the HyPTor makes it suitable for use at high temperatures. Also, the HyPTor is hydraulically formed and free from circumferential welds which would act as stress raisers.

Longer life on the job. The ability of the HyPTor to absorb punishment without ill effects has been proved in service. A number of HyPTor Expansion Joints designed for 700 psi working pressure, were installed in liquid oxygen service in 1948. They are still operating . . . at pressures up to 2300 psi.

Get the complete story of the new Zallea HyPTor Expansion Joints. Our new 72-page Expansion Joint Manual gives full details—plus worthwhile information on basic types, design and installation data, expansion joint selection and recommended specifications. Write on your Company letterhead, for your free copy of Catalog 56, Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

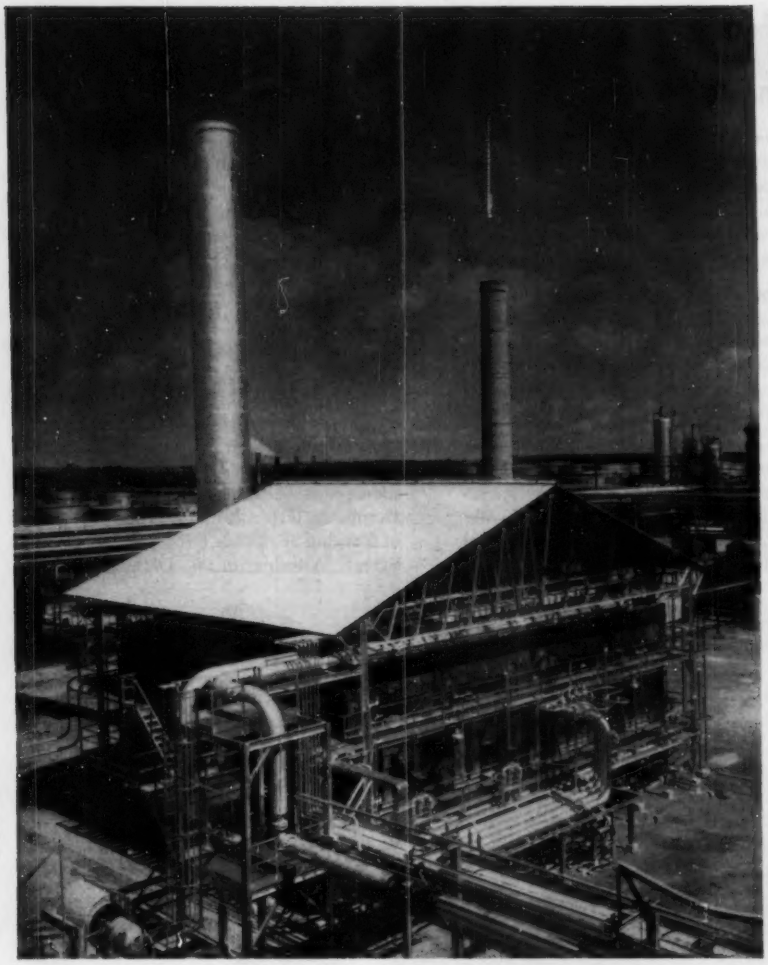
*Patented



Zallea
expansion joints

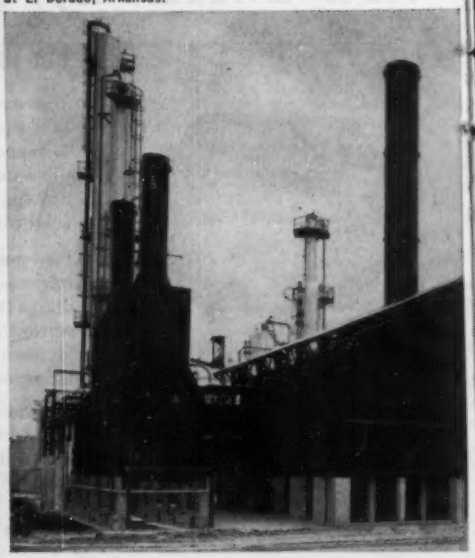
Zallea Brothers, Wilmington 99, Delaware

World's largest manufacturer of expansion joints.



Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.



Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

HIGHER EFFICIENCY, LUMMUS OIL HEATERS

Lummus designs horizontal and vertical-tube oil heaters to any size, for any process—anywhere in the world.

Major refiners confidently turn to Lummus on their important and difficult oil heater jobs.

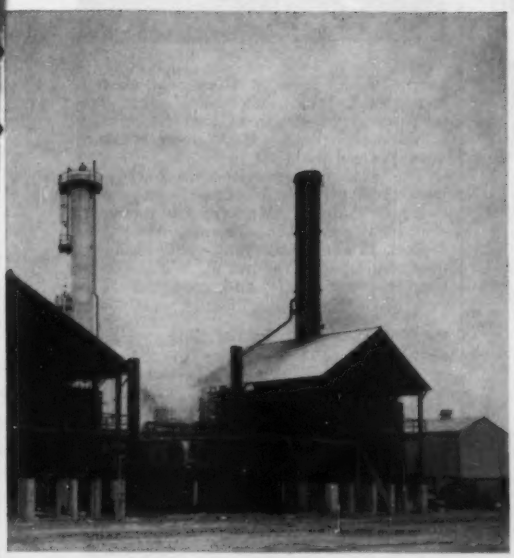
In the last 25 years, the combined capacity of all Lummus oil heaters built has exceeded that of any other company in the world. The reasons: greater durability, more efficient operation, an absolute minimum of days lost to downtime.

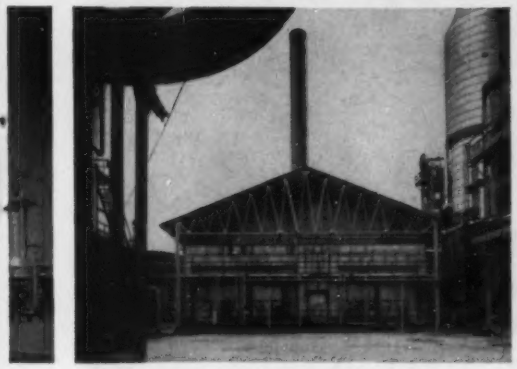
Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar.*

In 1957 alone, Lummus received contracts to engineer more than 130 oil heaters, with a combined absorbed-capacity of over 7,000,000,000 Btu per hour — the largest number of units and highest overall capacity in Lummus' oil heater history!

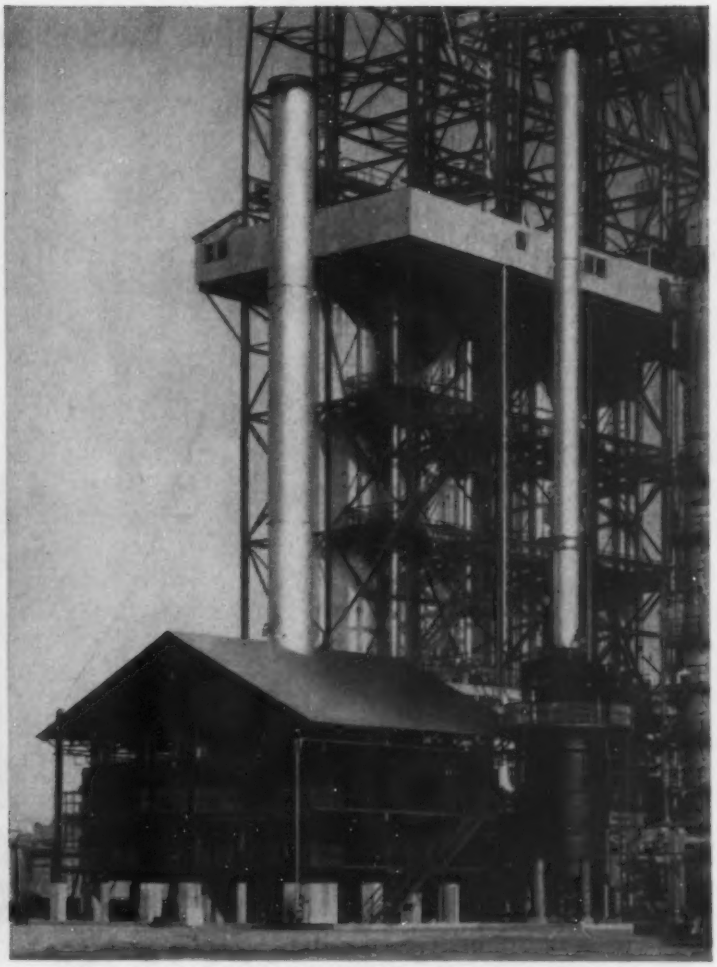
Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater,





Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

MINIMUM DOWNTIME MAKE PREFERRED AMONG MAJOR REFINERS

you can be sure that we will recommend the *right* unit for your needs. Complete Lummus facilities are available world-wide through any of the five international Lummus companies. Equipment is designed in New York, procurement is made through the nearest Lummus international office, and the cost of the job is payable in the currency of the country in which the procurement is handled!

Consult with Lummus on your next oil heater — large or small.

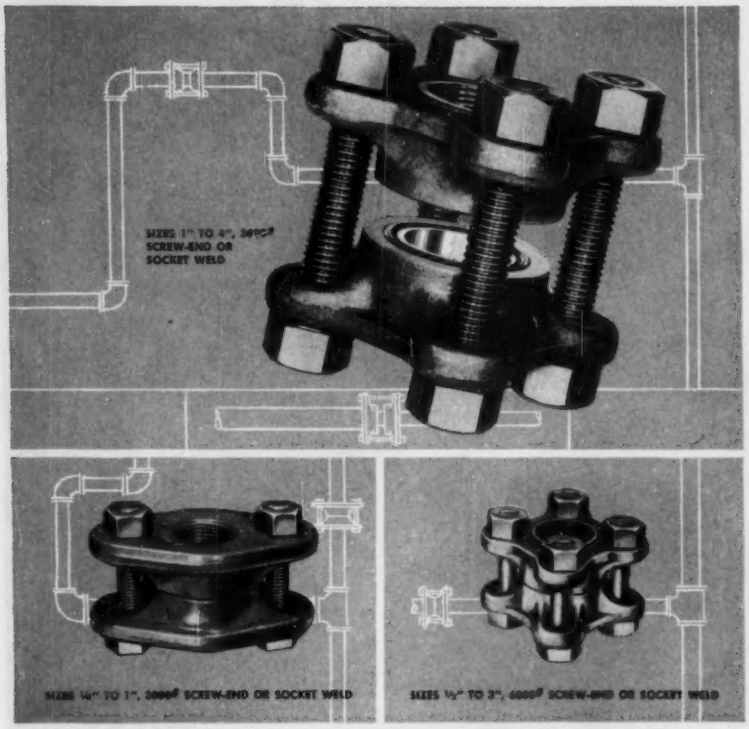
LUMMUS

THE LUMMUS COMPANY, OIL HEATER DIVISION
385 MADISON AVENUE, NEW YORK 17, N.Y.

WASHINGTON, D.C. • CHICAGO • HOUSTON • MONTREAL • CARACAS • MARACAIBO • LONDON • PARIS • THE HAGUE

For more data on advertised products, use Readers' Service Cards, last page.

The double diamond assures double value



Installation flexibility with permanent piping strength

GET BOTH WITH W-S O-RING FLANGE UNIONS

NOW, you can install high pressure piping systems that can easily be rearranged and adapted with full assurance that the unions will give the leak-proof service of permanent installations. This is made possible by these adaptable features of W-S O-Ring Flange Unions:

- Available in 2-bolt and 4-bolt types, according to size.
- Sizes ¼" to 1" in 2-bolt 3000#; sizes 1" to 4" in 4-bolt type 3000#; sizes ½" to 3" in 4-bolt type only 6000#.
- Available in Screw-end and Socket Welding Types—3000# and 6000#.
- O-Rings available in a variety of materials for a wide range of service.

Specify forged steel W-S O-Ring Flange Unions for a tight seal against fluid pressure in piping for hydraulic machinery, refrigeration piping, steam and water lines, process liquid and gas lines, and many other applications.

For full specifications, write for Bulletin U-1-58

W-S manufactures a full range of high quality drop forged fittings, unions and couplets... in carbon, stainless and alloy steels. For full information about these products, or for your specification forging requirements, write to: W-S Fittings Works, H. K. Porter Company, Inc., Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.

FORGE AND FITTINGS DIVISION

W-S Fittings Works, Roselle, N. J. • Cleveland Forge Works, Cleveland 4, Ohio
Stainless Steel Works, Duncannon, Pa.

Suppliers . . .

mittee. Also, **John S. Coey** was elected vice president, eastern chemical sales. The move creates a group of four senior vice presidents, including **R. Wolcott Hooker,** who received that title in 1956.

The new management committee is comprised of Moffitt, committee chairman; **R. Lindley Murray,** chairman of the board; Hooker, Dennis, Whitford, Wilkin, **F. Leonard Bryant,** vice president, production; and **Thomas F. Willers,** vice president, comptroller and treasurer.

MILTON ROY CO., at its July meeting, elected **Paul Gibian** vice president of manufacturing. He will be responsible for purchasing, product engineering and manufacturing in the company's Wyndmoor, Pa. plant. He was formerly manager of manufacturing.

Gibian

Gibian received a B.S. degree in mechanical engineering from Carnegie Institute of Technology and continued his studies at Massachusetts Institute of Technology from which he received his M.S. degree in 1948.

CHASE BRASS & COPPER CO. has appointed **Arthur W. Schriewer** Eastern regional stainless steel specialist. He was formerly product manager, Stainless Steel for the Edgcomb Steel & Aluminum Corp., with which he had been associated since 1945. He will make his headquarters at the Chase New York warehouse in Maspeth, L. I., and will cover the company's seven Eastern sales districts and warehouses.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has named **Norman A. Fletcher** manager of manufacturing for its Valve division. He will supervise all factory operations, including production control and purchasing. Fletcher joined Honeywell in 1956. He graduated from the University of Wisconsin in 1952.

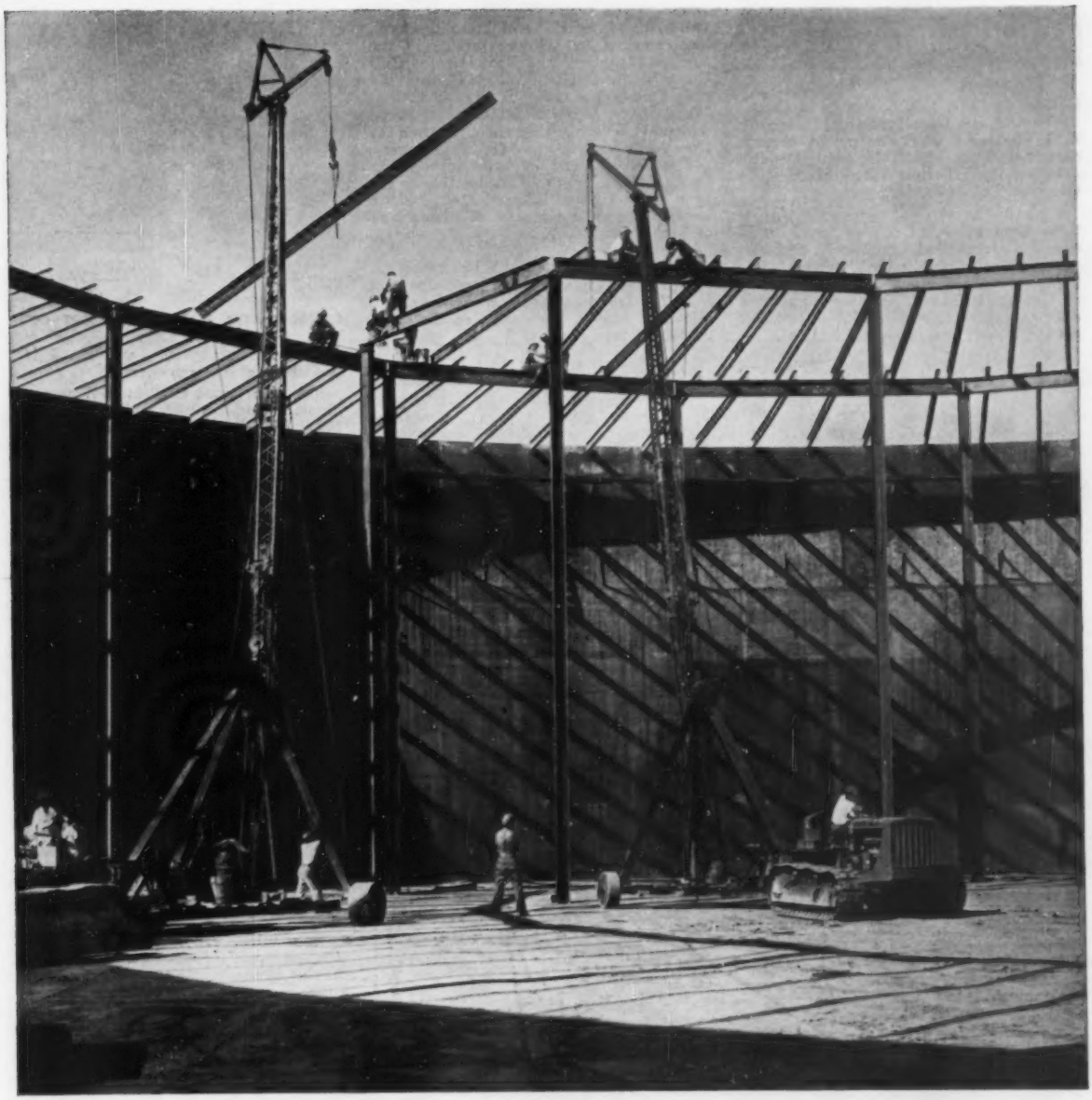
JONES & LAUGHLIN SUPPLY DIVISION has appointed **G. C. Pryor,** salesman at Laurel, Miss., store manager at Laurel. **L. R. Elston,** store manager at Virden, Manitoba, is assigned as store manager at Estevan, Saskatchewan. **P. C. Smith,** salesman at Woodward, Okla., is appointed assistant store manager at Morgan City, La.

E. B. Clark, storeman at Houston, is appointed assistant store manager at Houston.

CLIMAX MOLYBDENUM CO. has named **Dr. E. C. Herrick** chemical research supervisor for its Detroit Research laboratory. Prior to joining Climax, he was a research chemist for Houdry Process Corp. Formerly, he was in chemical research for American Viscose Co., E. I. duPont de Nemours & Co. and the Office of Naval Research at M.I.T.

Dr. Herrick received a B.S. degree in chemical engineering from Montana State

For more data on advertised products, use Readers' Service Cards, last page.



We build 'em big

This is a 250,000-bbl tank going up—and it's just one of twelve which we constructed at a large tidewater terminal. Each of these whoppers measures 200 ft in diameter by nearly 44 ft in height.

Are you considering the expansion of your storage capacity? Whatever size or type of tanks you may have in mind, you'll probably find that we've built a good many of them. Cone-roof, lifter-roof, spheres, and a variety of floaters—pan type, pontoon and double-deck—they're all available in Bethlehem designs, fabricated and erected to your requirements.

Would you like to have detailed information about Bethlehem Storage Tanks? Just get in touch with the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Suppliers . . .

College in 1941, a M.S. degree in chemical engineering from Princeton University in 1942 and a Ph.D. degree in organic chemistry from M.I.T. in 1949. He also attended the Wharton School of the University of Pennsylvania.

U. S. STEEL CORP.'s Oil Well Supply division has transferred **Menifee N. Swisher,** store manager at Powell, Wyo., to Farmington, N. M. He joined Oilwell in 1946 at Cut Bank, Mont., and was appointed store manager at Worland, Wyo., in 1948. He was transferred to Powell in 1952.

TRETOLITE CO., division of Petrolite Corp., has extended its refinery service in the Rocky Mountain and Louisiana Gulf Coast areas. **Philip P. Corneli,** formerly chemical engineer for Shell Oil Co. at Wood River, Ill., will be located at Baton Rouge. He is a graduate chemical engineer from Missouri School of Mines.

Dan Pietuch, refinery service engineer for Tretolite in the Chicago area, has been transferred to Billings, Mont., where he will service the Rocky Mountain and western Canadian refineries.

SCHUTTE AND KOERTING CO. has appointed **William T. Conway** sales representative for Northeast New York. He will provide sales and engineering service in that area for all SK products.

Weldynamics

ARC WELDING AT WORK CUTTING COSTS

We welded 14 miles of Stainless Steel piping with Lincoln's Stainweld electrodes. All welds were tested under pressure, and I'd like to say that we have never had such good welds.

Tom R. Gallagher

Houston, Texas

Your weldor's opinion is worth a thousand words

Write for the new Lincoln Weldirectory of Stainless Steel Electrodes. Ask for Bulletin 7000.2.

The World's Largest Manufacturer of Arc Welding Equipment

LINCOLN

THE LINCOLN ELECTRIC COMPANY · DEPT. 2216 · CLEVELAND 17, OHIO

Robinson

Cole

CONSOLIDATED ELECTRODYNAMICS CORP. has appointed **Dr. Charles F. Robinson** chief research physicist, and **Dr. Leland G. Cole** chief research chemist.

Robinson joined CEC in 1947 as a staff physicist and became senior physicist in 1952. He has an A.B. degree in general science and mathematics from Southwest Missouri State College, a B.S. degree from Drury College and M.S. and Ph.D. degrees from Cal Tech. He is a member of the American Physical Society, ASTM, American Association for the Advancement of Science, and the New York Academy of Sciences.

Cole joined Consolidated in 1955 as senior chemist. He has a B.S. degree in chemistry and M.A. and Ph.D. degrees in physical chemistry from Oregon State College, and is a member of ACS, American Institute of Chemists, American Association for the Advancement of Science, American Association of University Professors, American Ordnance Association and The American Rocket Society.

NATIONAL CONSTRUCTORS ASSN. has appointed **Richard E. Chislett** secretary-treasurer. He was formerly chief of the Employer Relations Section, International Labour Office, Geneva, Switzerland. Before that he was with Standard Oil Co. (N. J.) and the Newark (N. J.) Chamber of Commerce.

DANIEL ORIFICE FITTING CO. has appointed **Howard Bean,** formerly with the National Bureau of Standards, Washington, D. C., a flow measurement consultant. The physicist was chief of the Bureau's Gas Measurement Instruments section, and the Capacity, Density and Fluid Meters section for over 40 years. He is a member of A.S.M.E., A.G.A., the Washington Academy of Sciences, and Sigma Xi.

OKONITE CO. has appointed **Edward Danielson, Jr.,** regional manager of the newly-created West Coast region. A graduate of the University of Texas with a degree in mechanical engineering, Danielson joined the company's San Francisco office in 1947, serving as office manager and district engineer. In 1950, he was named district manager of the Los Angeles office, which post he filled until his recent promotion.

PRODUCTS INTERNATIONAL OF ENGLAND, a wholly owned subsidiary of Crane Packing Co. of Chicago, has appointed **L. T. Hulin** managing director of the company.

ORBIT VALVE CO. has promoted **J. J. Gavin,** former eastern sales representative, Pittsburgh, to eastern division sales manager.

Don DeSirey, Tulsa area sales representative, is being transferred to Odessa, Texas, to replace **Don O. Meeker,** who

THERE'S GOOD NEWS TODAY...

at PROCON

Philadelphia, Pennsylvania—Work was recently completed on two 26,000 B/SD Platforming® units at Gulf Oil Corporation's Philadelphia refinery by Procon Incorporated. Two 26,000 B/SD Hydrobon® units used with the Platformers were also built by Procon. The Platformer heaters were the largest ever built. Procon engineers recommended single heaters for each Platforming unit instead of two smaller heaters for best use of available space and maximum construction economy.

London, Ontario, Canada—Procon (Canada) Limited recently completed the installation of flaking mills, ovens, conveyors, dust collection systems and related equipment as part of a plant modernization program for Kellogg Company of Canada, Ltd. This construction covered improvements to Kellogg's cereal processing plant at London, Ontario.

Al Kuwait, Kuwait—Work is proceeding on 4,000 B/SD Platforming-Unifining* units and a 7,200 B/SD prefractionator being built by Procon (Great Britain) Limited for Kuwait Oil Company at Kuwait on the Persian Gulf. Work covers mechanical and structural design, engineering, procurement, inspection and supervisory services for Kuwait.

Heide, Germany—Construction was recently completed on a 4,000 B/SD Platforming unit under the supervision of Procon (Great Britain) Limited for Deutsche Erdol-Aktiengesellschaft (DEA). This is part of an extensive reconstruction program, and will supply premium gasoline to Northern Germany and Denmark.

Bakersfield, California—The construction of Mohawk Petroleum Corporation's 925 B/SD Unifining unit was recently completed by Procon Incorporated. This unit processes thermally cracked naphtha derived from California crude. The Unifining unit was built at Mohawk's Bakersfield, California, refinery.

Procon service is available to the oil refining, petrochemical and chemical industries, anywhere in the world. New plant construction, expansion or modernization, whatever the requirement, Procon will do it right, and on time.

*Trademark

PROCON *Incorporated*

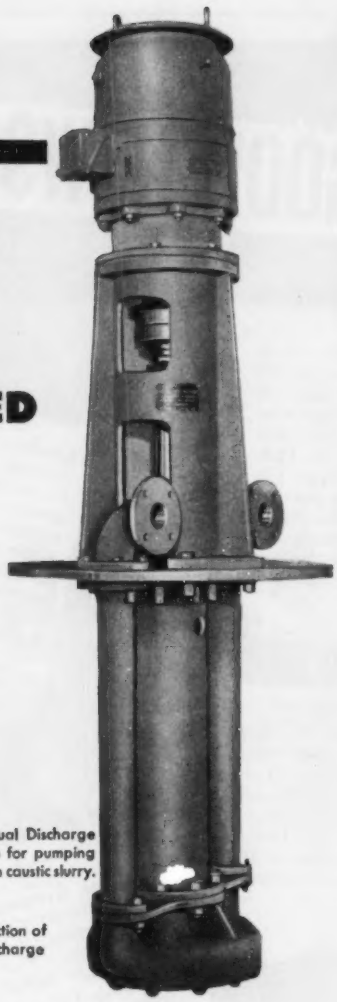
1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U.S.A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. 1, ENGLAND
PROCON INTERNATIONAL, S. A., SANTIAGO DE CUBA

WORLD WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

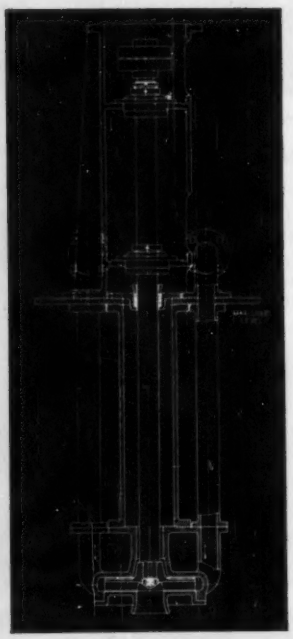
For more data on advertised products, use Readers' Service Cards, last page.

VERTICAL PUMPS WITH NO SUBMERGED BEARINGS FOR PUMPING ABRASIVE CORROSIVE SLURRIES



2" Dual Discharge Pump for pumping molten caustic slurry.

Cross section of Dual Discharge Pump.



This rugged type of service calls for advanced design: — extra heavy shaft, double-ported casing to equalize the side thrust of the impeller, and tough abrasion-corrosion resistant alloys. The dual discharge pump illustrated here incorporates these features and dispenses with bearings or packing below the cover plate where they would be in contact with the liquid.

Difficult pumping problems, particularly in the process industries, have been our specialty for ninety-one years. Perhaps we can be of help to you. Write us — no obligation.

Write for Bulletin 203-6 for complete summary of acid and chemical pump data.

LAWRENCE PUMPS INC.

371 MARKET STREET, LAWRENCE, MASS.

Suppliers . . .

has been assigned to Farmington, N. M. **Joe F. Brunsman** will be shifted from Farmington to Oklahoma City. **Joe Schoeffler** will be transferred from Houston to become Orbit's Tulsa area sales representative.

West Coast changes are: **Charles Lowe Co.** to represent Orbit in northern California, Oregon and Washington; and **Marshall E. Niedecker Co.** to represent the company in southern California.

G. M. WALLACE AND CO., Denver, Colo., representing Cochrane Corp. for water treating and steam specialty equipment, has opened a branch office at El Paso.

The office is under the direction of **B. M. Huffman.** He is a mechanical engineering graduate of the University of Texas.

GENESYS CORP., a subsidiary of Chance Vought Aircraft, Inc., has entered the industrial process control field. Product development will be headed by **John P. Lekas,** vice president. Before attaining his present position, Lekas was head of special devices and magnetic recording groups at Litton Industries, North American Aviation, N.A.C.A. and others.

Lekas

Systems engineering will be headed by **Geoffrey Post,** vice president. Formerly associated with Allen B. DuMont Laboratories, Servomechanisms, Inc. and other electronic manufacturers, he formerly headed process control computer developments at Litton Industries.

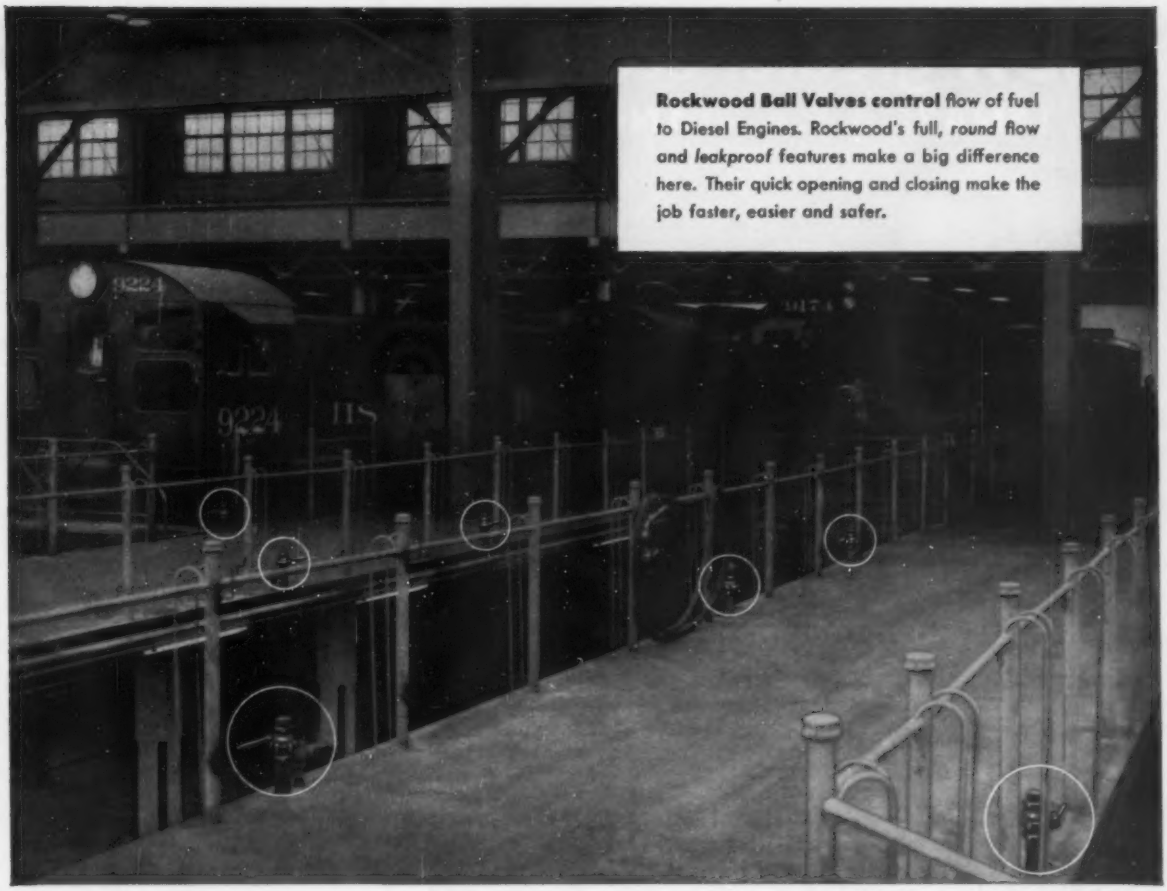
Marketing activities will be headed by **John F. Davis,** vice president. Prior to joining the company he was manager of the Computer Sales department at Litton Industries and was formerly with Neely Enterprises.

IRVING SUBWAY GRATING CO., INC., has elected **James E. Irving** president of the company. Irving succeeds his father, the late Walter E. Irving.

Irving

Irving was previously executive vice president of the company, a post he held since June, 1945. He was elected president of the company's Western division in 1955, a position he still retains in addition to his new duties. He is also president of Enrejados Irving de Mexico, S. A., the company's manufacturing plant in Mexico.

BUCYRUS-ERIE CO., Milwaukee, Wis., has appointed **Alexander L. Bupp** its assistant treasurer, manager of planning. The new position includes corporate planning, market research, organization planning and office management. He joined Bucyrus-



Rockwood Ball Valves control flow of fuel to Diesel Engines. Rockwood's full, *round* flow and *leakproof* features make a big difference here. Their quick opening and closing make the job faster, easier and safer.

Flammable liquids handled with safety ... without leakage ... without delay

Rockwood Ball Valves are ideal for handling flammable fuel oils. They handle quickly, easily! The reasons are —

Rockwood Ball Valves with *Full Round Flow* eliminate turbulence and provide minimum friction loss.

Only a quarter turn is needed to open or close the valve.

Rockwood Ball Valves have a chrome-plated ball that holds up under tough abrasion, pitting and scratching — that means *Long Wear-Resistance.*

Rockwood exclusive corrugated spring design and the pressure of the fluid *automatically* position the ball against the seat for a completely *Leakproof Seal.*

These features pay off on handling fuel oils. Rockwood Ball Valves deliver flammable fluids at the volume you want quickly, without leakage and a minimum of maintenance. The only other thing you could ask for is more information — and the coupon below will get it for you.

Tested and listed by Underwriters' Laboratories, Inc. Distributors in principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
1023 Harlow Street
Worcester 5, Mass.

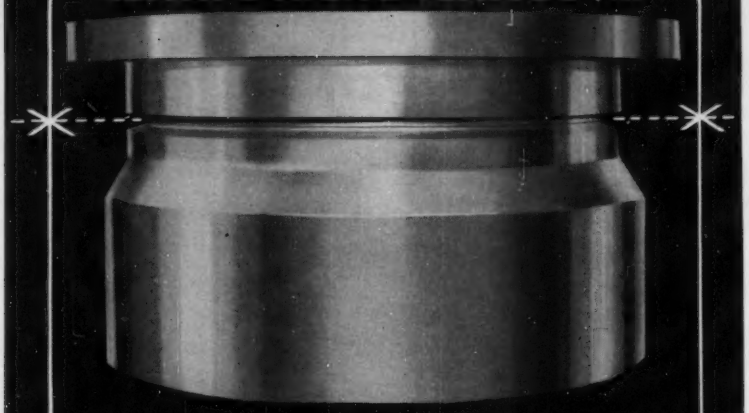
Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....
Title.....
Company.....
City.....
Zone.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.

NOW greater economy

LENAPE A.S.A. FLANGE *Plus*



LOW COST WELD END EXTENSION

For many pressure vessel requirements, progressive designers are specifying economical Lenape flanges and seamless weld end extensions in place of more costly long welding necks in I.D. sizes from 16″ to 24″.

Check these distinct advantages:

LENAPE FLANGES OFFER:

- Full I.D. opening for easier access and replacement of vessel internals.
- Wall thickness equivalent to more expensive Seamless Welding Necks.
- Special facings in solid material.
- Positive flange cost economy.

LENAPE SEAMLESS EXTENSIONS OFFER:

- Full I.D. opening free from constrictions imposed by pipe.
- Heavier walls than either pipe or rolled plate—greater corrosion and pressure resistance.
- No axial seam to be radiographed.
- Inherent reinforcement.

IN COMBINATION:

- Economy in lengths beyond 12″ overall as compared to Seamless Welding Necks.
- Joining weld is X-rayable, in contrast to a slip-on flange.
- Extension may first be welded to vessel, then flange welded to extension without refacing the flange.

Write today for detailed specifications.

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

LENAPE PRESSURE VESSEL CONNECTIONS

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.
RED MAN PRODUCTS

Suppliers . . .

Erie in 1939 as a special apprentice following his graduation from Lehigh University with a B.S. degree in industrial engineering. He served as sales engineer and later, for a number of years, was assistant manager of the export sales department prior to his appointment as assistant treasurer two years ago.

FOOD MACHINERY AND CHEMICAL CORP. has named **Robert B. Brown,** staff assistant of its organization planning and market research group in San Jose, Calif., manager of market research for the company's Peerless Pump division with headquarters in Los Angeles. A graduate of Stanford University, with a B.S. degree in industrial engineering and a M.S. degree in business administration, he joined FMC six years ago as a member of the Organization Planning department in San Jose. From 1953 until 1955, he served as assistant manager of FMC's Washington, D. C., office.

GRAVER WATER CONDITIONING CO. has a new sales structure covering the following fields: industrial; industrial waste treatment; chemical processing; foreign operations, and process engineering. Managers have been named for each of them.

The sales engineering department has been replaced by the Process Engineering department. The former Industrial Water Treatment department has been divided, with one department to have responsibility for power plant utilities and the other to deal with all other industrial applications.

The new managers and their posts are: **George Apfel,** process engineering; **N. S. Chamberlin,** chemical processing; **J. D.**

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the registry.

Cyclobutane
5.5-Dimethylcyclopentadiene
Tetradecylmethyl ketone
1-Methylcyclobutene
1,1,1-Trichloro-2-propanol (Isopral)
p-Nitrobenzenediazonium p-toluene sulfonate
Propane-1,3-dithiol-2-carboxylic acid
Chloramide
N,N′-Dimethyl-decahydro-2-naphthylamine
Perchlorocyclohexane
Perchlorocyclohexene
2,2′-Thiobis(4-chloro-6-methyl phenol)
N-(2-Naphthyl) phosphoramidic acid
Hexadecylmethyl ketone
3-Hydroxy-4-methoxycinnamic acid (Isoferulic acid)
2-Isocyanatopropane
β,β,β-Trichloroborazole
2,3′-Bipyridine
Pentachlorocyclopentadiene
3′,3″,5′,5″-Tetrabromophenolphthalein ethyl ester, potassium salt

For more data on advertised products, use Readers' Service Cards, last page.

CRESCENT
POLYETHYLENE INSTRUMENT TUBING
Costs Less—Is Easier To Install

SIX DIFFERENT TYPES TO MEET YOUR SPECIFIC NEED

CRESCENT POLYETHYLENE MULTITUBE is 2 to 37 precision Polyethylene tubes *spirally cabled* together for greatest flexibility. The tubing assembly is protected against mechanical injury by an interlocked galvanized steel armor, Polyvinyl Chloride sheath, or other sheaths, as below.

CRESCENT POLYETHYLENE PRECISION INSTRUMENT TUBING

TYPE P is manufactured from the best high molecular weight virgin Polyethylene compound and TYPE XP of high modulus virgin Polyethylene compound selected for their superior resistance to environmental stress cracking and aging. Extensive research, improved manufacturing methods and rigid test standards have developed CRESCENT Polyethylene tubing to its present level of highest quality. It is furnished as single tubing in ¼", ⅜" and ½" sizes in up to eight bright colors. It is used exclusively in manufacturing CRESCENT POLYETHYLENE MULTITUBE in types as follows:

STANDARD TYPES

TYPE PA
Interlocked metallic armor provides complete mechanical protection.

TYPE PAT
Polyvinyl chloride sheath over the armor adds corrosion protection for the armor. Can be buried in the earth.

TYPE PT
PVC sheath gives limited mechanical potection. For use in troughs, trays or conduit.

SPECIAL SERVICE TYPES

TYPE XPT-U
Extra heavy PVC sheath over high modulus TYPE XP tubing permits direct burial, or use above ground where subject to moderate abuse.

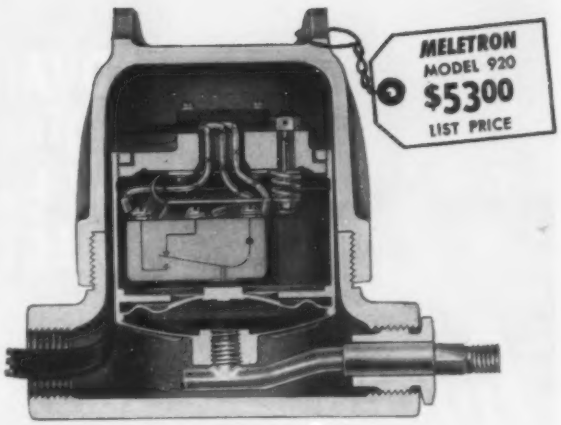
TYPE XPT-F
Same as XPT-U with heavy asbestos braid and outer PVC sheath. Provides time delay in event of flash fire.

TYPE XPT-FA
Same as XPT-U with heavy asbestos braid and interlocked metallic armor. Provides complete mechanical protection, as well as time delay in event of flash fire.

Write for complete information on these types, as well as types employing copper or aluminum tubing. Ask for new Bulletin No. 458.

Visit us at Booth #1155 at I.S.A. Show, Philadelphia, Sept. 15-19, to discuss this answer to low cost pneumatic instrument tubing problems.

CRESCENT
INSULATED WIRE & CABLE CO. INC.
TRENTON 5, N. J.



Here's the Simplest Diaphragm Pressure Switch for Explosive Atmospheres

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

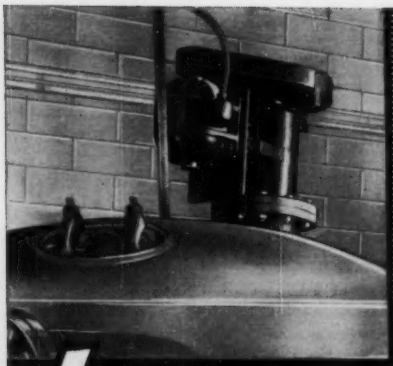
Ask for bulletins 920-925

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.



ADVANCED Engineering - and better SELECTION -- with

"International" MIXERS

SIDE ENTERING

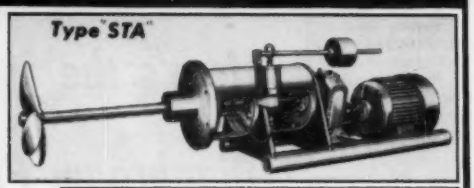
Each of these different types of Mixers has its particular mechanical advantages which make it more efficient for specific purposes. There are many considerations in every application where a wide range of types and materials must be available.

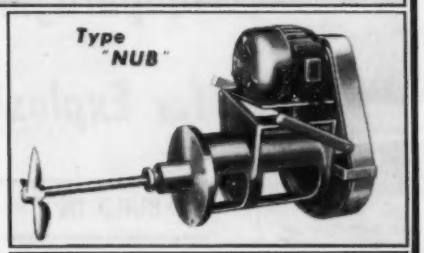
. . . . With the complete "INTERNATIONAL" Line of Mixing Machinery to choose from, you can be sure of our unbiased recommendation of the right type mixer for each specific job.

Special Metals used in Mixer construction are available—iron, bronze, stainless steel, high nickel alloys, etc.—You pick the sealing arrangement, either standard packed or New Mechanical Seal. Your choice of Power drive—Gearmotor, V-Belt or Silent Chain.

MOTOR Selection—Any standard motor with NEMA frame—any current, insulation or enclosure.

GUARANTEED PERFORMANCE—25 Years of continuous building, testing, study and research experience goes into every "INTERNATIONAL" application—it assures you of getting exactly the right Mixer for top performance and economy.





Showing application how Mechanical Seal can be adapted to standard Inside Type stuffing box.

TOP ENTERING MIXERS

"INTERNATIONAL" Vertical Drive Heads are made in various types and sizes from 1 to 100 H.P. for Propeller and Turbine agitation,—slow speed or high speed—and for Open or Closed Tanks and vessels. Standard Stuffing Box or New Mechanical Seal.

PORTABLE MIXERS

The most adaptable Mixer ever built. Patented. High Speed, Slow Speed and Intermediate. Production and Laboratory Models—Special Bulletin 74 B

International Engineering, Inc.

DAYTON 1, OHIO

New York · 15 Park Row

New Catalog of Mixing Equipment No. 83, sent on request.

Suppliers . . .

Crell, foreign operations; **Robert Dvorin**, industrial waste treatment; **E. A. Strahlendorff**, industrial water treatment; and **R. S. Lewis**, sales promotion.

WORTHINGTON CORP. has named **A. E. Carter** vice president of manufacturing. He joined Worthington from Ford Motor Co., where he was manager of the Ford parts plant at Rawsonville, Mich. Previously, he had served as assistant general manufacturing manager in charge of manufacturing staff operations with the Ford Tractor and Implement division, Birmingham, Mich.

NORTON CO. has assigned **Murner E. Thor**, a refractories engineer in New York since 1950, to the Midwest. He will service refractory accounts in Wisconsin, Iowa, Minnesota and parts of Illinois.

Thor graduated from Iowa State College with a degree in ceramic engineering.

THE OHIO INJECTOR CO. has elected **Dana M. Norton** vice president of industrial relations. He comes from Curtiss-Wright Corp., where he was director of industrial relations at Utica, Mich. Before that, he was industrial relations executive with Ford Motor Co., Dearborn, Mich. Norton graduated from the University of Chicago Law School in 1932.

HUDSON-RUSH CO. has placed **R. Mack Goble**, an engineering graduate of the University of Texas, in the Shreveport office to assist **Morley Hudson**, president, with sales and application engineering. Goble was formerly with the Industrial division, Minneapolis-Honeywell Regulator Co. in El Paso and Shreveport.

Wally Hopkins, another engineering graduate of the University of Texas, has joined **Jack Rush**, vice-president, in the Dallas office. Hopkins was formerly with a firm manufacturing boilers, burners and combustion controls.

CHICAGO BRIDGE & IRON CO. has assigned **Harry G. Pazucha**, formerly of the General Sales department, to the Chicago sales staff. He has been with CB&I since 1952 and holds a B.S. degree from Illinois Institute of Technology.

Rich J. Bassett has been transferred from the Salt Lake City plant to the Kansas City sales office. He joined CB&I in 1954, shortly after his graduation from the University of Utah with a B.S. degree in civil engineering.

KAISER STEEL CORP. has appointed **Walter W. Peters** to its sales staff. He was formerly tubular sales service manager at the company's general sales office in Oakland, Calif.

Before joining Kaiser Steel's sales department in 1954, ePters was a partner in a building contracting firm. He attended Stevens Institute of Technology and the University of California at Berkeley.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has made several organizational changes in the Industrial Products group.

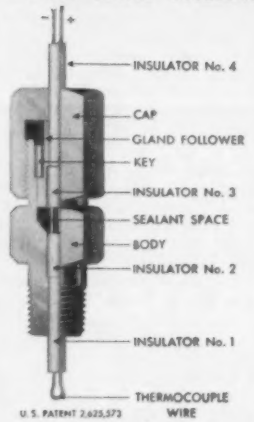
George M. Muschamp was named group vice president, engineering, and **O. B. Wilson**, formerly a sales vice president, was named group vice president, marketing. **John M. Wilson**, head of design and development, became director of engineering.

R. L. Mallory, Southwest regional man-

Fast Response

conax®

BARE WIRE THERMOCOUPLE GLANDS



U. S. PATENT 2,625,573

provide the only simple, positive method for sealing two or more bare wires at pressures from full vacuum to 20,000 psi.

Low mass, unshielded, bare wire thermocouples give almost instantaneous response to temperature changes assuring greater accuracy of measurement and control.

- Temperature range—−300°F to +1850°F
- All stainless steel construction
- Complete range of sizes
- Available from stock

WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

conax corporation
2328 Walden Ave., Buffalo 25, New York

INHIBIT DERMATITIS

AND OTHER ANNOYING SKIN INFECTIONS WITH

ALL PURPOSE SKIN CLEANSER

WITH EFFICIENT DISPENSERS Portable and Stationary Throughout Your Plant

Recognized throughout industry as a superior, heavy duty paste-cream antiseptic skin cleanser, VI-LAN fortified with Lan Act 12, is properly dispensed with portable and stationary dispensers conveniently placed on work benches, service trucks, oil rigs, laboratories, store rooms, work carts, lavatories, and in EVERY WASH ROOM.

No. 50

Used WITH OR WITHOUT WATER, Vi-Lan removes greases, oils, paints, tars, acids, asphalt, pipe dope, rubber, etc., inhibits dermatitis, and serves to eliminate lost man hours and expensive compensation claims.

No. 60-70

It drastically reduces hand-cleaning costs and removes stubborn soils in less time than conventional soaps and detergents. IT DOES WHAT SOAP CANNOT DO and its lanolin content preserves natural skin qualities.

Write for descriptive folder: "Keep Their Hands Clean and Germ Free."

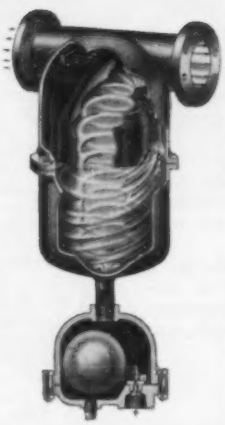
DAMERON ENTERPRISES, INC.

427 South 20th Street
Louisville 3, Kentucky

New Design Assures Maximum Entrainment Removal With Low Cost "T" Separator

Redesigned annular passage increases centrifugal force. Separated moisture, oil and solids travel outer wall to lower collecting chamber. Large diameter, high level outlet reduces velocity, eliminates entrainment problems. Screwed ends ½" thru 3". 125 lbs. flanged ends 2½" thru 8". Low cost in-line installation.

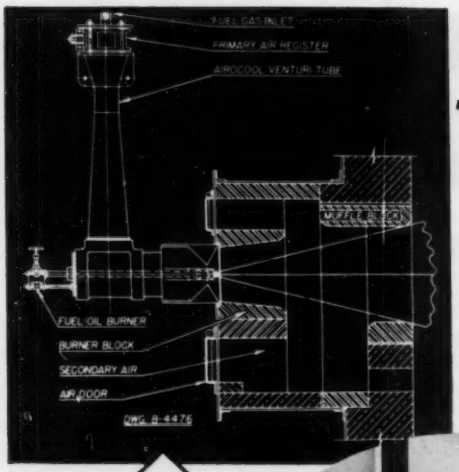
Combined with No. 90AC automatic drain trap to prevent loss of steam, air or gas provides most efficient and economical separator-drain combination available.



WRITE FOR BULLETIN TB-541-B

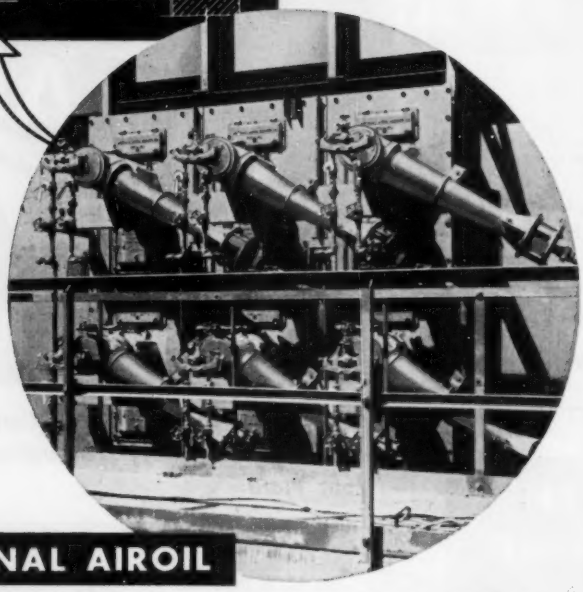
WRIGHT-AUSTIN COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.

For more data on advertised products, use Readers' Service Cards, last page.



Firing

CRUDE DISTILLATION UNIT HAVING WORLD'S HIGHEST THRUPUT . . .



NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Looming large in the effort to meet increased products demand on the petroleum industry is Tidewater Oil Company's ultra-modern Delaware Refinery, for which C. F. Braun & Co. were the engineers and constructors.

At the Tidewater Oil Company's ultra-modern Delaware City refinery this huge crude furnace for a world's record capacity of 130,000 barrels per day is equipped with National Airoil Burner Company's exclusive Tandem Block Combustion Units which are easily capable of exceeding the designed capacity of the furnace when burning either liquid or gaseous fuels.

These Tandem Units will burn up to high viscosity residuum oils and/or varying molecular weights of refinery gases. They have high individual heat liberating capacity as well as turn down ratio on natural draft thus avoiding the cost of a blower system. They will operate with low excess air.

Because these high combustion efficiency Tandem Units liberate a large proportion of heat by flame radiation to the heat absorbing surfaces, they increase the days on stream by reducing flame impingement with its accompanying high maintenance cost to tubes, brick work, etc.

National Airoil

BURNER COMPANY, INC.

Main Office & Factory: **1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.**

SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS

Suppliers . . .

ager, has been named sales manager of the Industrial Products group.

In other assignments, **J. A. Robinson**, field sales manager, was appointed sales manager, of Brown Instruments division; **Howard J. MacDonald**, assistant general manager, was made general manager of the Valve division, and **H. Earl Benson**, senior sales engineer in the Cleveland regional office, becomes sales manager for Rubicon division.

A. O. SMITH CORP. has made sales organizational changes affecting its Meter and Service Station Pump divisions. **J. W. Harris**, formerly area manager at Houston, will be national sales manager, Engineered Products; **W. T. Schultze** has been promoted to area sales manager, Northeast territory; and **W. D. Burns** has been appointed area sales manager, Plains territory.

CHEMETRON CORP. has appointed Samuel **A. Pond** personnel director on the firm's corporate staff. He will direct personnel matters for the company, coordinating personnel activities of the divisions and subsidiaries.

For the last five and a half years Pond was director of industrial relations of the chemical divisions of Food Machinery & Chemical Corporation. He joined that company in 1950 as assistant to a divisional director of industrial relations.

PYROMETER COMPANY OF AMERICA has just been formed in Penndel, Penn. The firm's general offices and plant are 20 miles northeast of Philadelphia.

Officers, all with experience in the instrument and thermocouple application, manufacturing and distributing fields are: president, **John V. Metzger**, vice president, **Leonard Bonn**; sales manager, **C. J. Smolinske**, and chief engineer, **Edward R. Stroik.**

AMERICAN CYANAMID CO.'s Organic Chemicals division has named **Raymond L. Stout** manager of the Budget and Statistical department. Formerly assistant to the division's director of sales, Stout joined Cyanamid in 1930. Since that time he has served in other administrative capacities including that of divisional manager of office services. He attended Rutgers University.

WAUGH ENGINEERING CO., Van Nuys, Calif., has named Revel H. Smitter general sales manager for the company. He will supervise all sales activities for Waugh throughout the U. S. and Canada.

Formerly with Minneapolis-Honeywell Regulator Co., he was sales engineer for the Industrial division, and later Western regional manager for that firm's Boston division.

GENERAL ELECTRIC CORP.'s Distribution Assemblies department has named **A. A. Watson** manager of marketing, assemblies, and components sales. **R. C. Wilson** has been named manager of manufacturing and plant operations.

Prior to his present appointment, Watson was manager of assemblies and components sales. He has been with G-E since 1936, when he joined the Trumbull Electric Manufacturing Co., then a G-E affiliate, as a sales engineer.

Wilson, for two and one-half years prior

For more data on advertised products, use Readers' Service Cards, last page.

POSEY
STEEL PLATE
FABRICATION

For The Petroleum Industry

Whether it's a 30,000-gallon propane storage tank like the one illustrated above . . . or a fractionating tower . . . or large O.D. alloy steel pipe . . . or piling for off-shore drilling rigs . . . we have the experience, the facilities and the skilled workmen to meet your most exacting fabricated steel plate requirements. Write, wire or telephone for information or quotations.

POSEY IRON WORKS, INC.

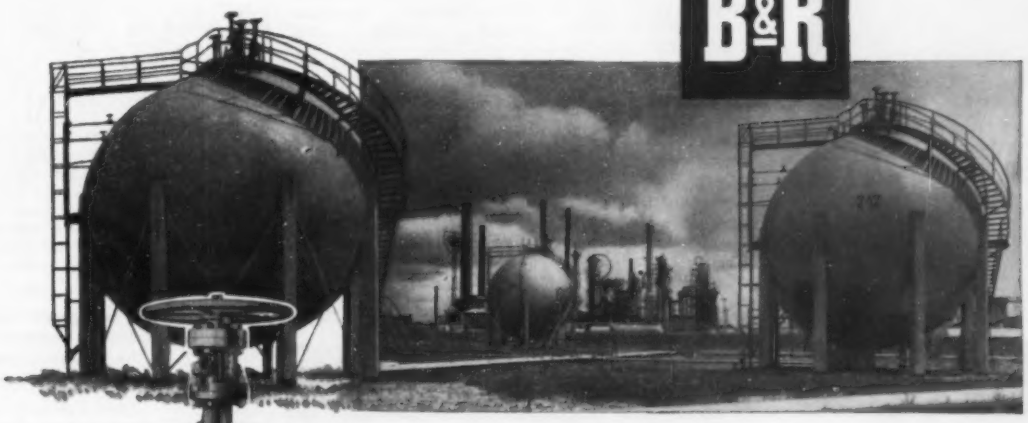
Steel Plate Division

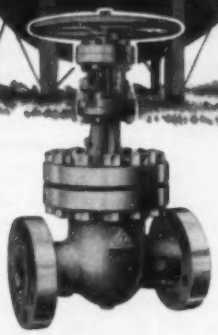
LANCASTER, PENNSYLVANIA

New York Office: Graybar Building

TUNNEL AND MINE EQUIPMENT • IRON AND STEEL CASTINGS • ASPHALT PLANT EQUIPMENT • BRICK MACHINERY AND MIXERS • INDUSTRIAL HEATING EQUIPMENT

B&R





Oe 649 1e

Oil refineries

in many countries successfully equipped their modern plants with B&R Gate Valves, Globe Valves, Swing Check Valves, Safety Valves. B&R Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM. One trial with our Valves will make you our customer for ever. Please ask for B&R catalog We 110e with detailed particulars on our lines of **oilfield and refinery equipment.**

BOPP & REUTHER G·M·B·H MANNHEIM-WALDHOF

WESTERN GERMANY

YOURS for the asking!

Available NOW!

Send for this DOYLE & ROTH LITERATURE TO-DAY!

1 HEAT EXCHANGERS BULLETIN No. 158-HE

A size and type to meet every application and requirement of the chemical and process industries. Time and money can be saved by placing complete responsibility with Doyle & Roth.

2 TANK TRANSPORTS BULLETIN No. 257-T

Individually engineered for each specific operation . . . there is a D. & R. Transport for every liquid hauling purpose in the chemical and process industries.

3 "PACKAGED" LIQUID COOLERS BULLETIN No. 257-C

For your unusual cooling requirements . . . specifically designed for the chemical and process industries . . . to produce chilled liquids in volume . . . quick . . . efficient . . . and, at LOW COST.

4 PILOT PLANT EQUIPMENT

Doyle & Roth can manufacture and supply a complete line of "pilot-size" Reactors, Heat Exchangers, Pressure Vessels, Columns and Tanks.

FOR COMPLETE INFORMATION

FILL OUT AND MAIL Coupon Today!

DOYLE & ROTH *Manufacturing* CO. INC.

136-50 Twenty-fourth Street Brooklyn 32, New York

Please send me the following Doyle & Roth literature . . . CEP May 1958

CHECK THE BROCHURES YOU DESIRE

1 ☐ HEAT EXCHANGER BULLETIN NO. 158-HE 2 ☐ TANK TRANSPORTS BULLETIN NO. 257-T 3 ☐ LIQUID COOLERS BULLETIN NO. 257-C 4 ☐ PILOT PLANT EQUIPMENT

FIRM NAME .....

INDIVIDUAL .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

Suppliers . . .

to his new appointment, served as the department's manager of marketing. From 1953 through mid-1956 he was manager of engineering. He joined G-E in 1941.

JEFFERSON CHEMICAL CO.'s Marketing department has appointed **J. W. McCarthy** technical service representative. He will be responsible for servicing customer accounts and assisting in maintaining and developing market outlets.

McCarthy is transferring from Jefferson's Manufacturing department where he has been a process engineer for the past year. Formerly with Phillips Chemical Co. and Civil Engineering Corp., he received a B.S. degree in chemistry in 1948 and a B.S. degree in chemical engineering in 1949 from the Texas College of Arts and Industries. He holds a M.S. degree in chemical engineering from the University of Oklahoma.

SCHLUMBERGER WELL SURVEYING CORP., Ridgefield Instrumentation division, has appointed Scientific Supplies Co., Ltd., and Philips Electronics Industries Ltd., as its distributors in Canada.

FLEXONICS CORP. has formed four regional sales offices. They are headed by regional sales managers, including: **L. J. Cullen** in Illinois; **R. G. Arnold** in Michigan; **H. V. Tastrom** in New Jersey; and **G. W. Derum** in California. A fifth regional office at Memphis, Tenn., is scheduled for future activation.

COLUMBIA-SOUTHERN CHEMICAL CORP. has appointed **G. John Lambillotte** assistant to the general traffic manager. Prior to his appointment he was a project engineer. He joined the Ohio plant as a development engineer in 1947 and served there in engineering work before moving to Pittsburgh.

BRODIE METERS CO. has appointed **J. R. Trayler** a member of its field sales staff in the Northern California division.

During more than 20 years with Brodie, Trayler has been chief inspector, assembly superintendent, service manager of the Eastern division, and has held various sales positions.

ELECTRIC STEEL FOUNDRY CO., Portland, has been appointed exclusive sales representative for the Foundry division of Hills-McCanna Co. in 11 western states.

THE RAMO-WOOLDRIDGE CORP. has given four vice presidents new responsibilities. **Dr. Ralph P. Johnson,** formerly vice president, research and development, has been named group vice president in charge of the General Electronics group of divisions. He will direct all research, engineering, manufacturing, and administrative activities of the company except space technology and The Thompson-Ramo-Wooldridge Products Co.

Dr. Burton F. Miller, formerly vice president and director of the Communications division, becomes vice president and director of advanced systems planning.

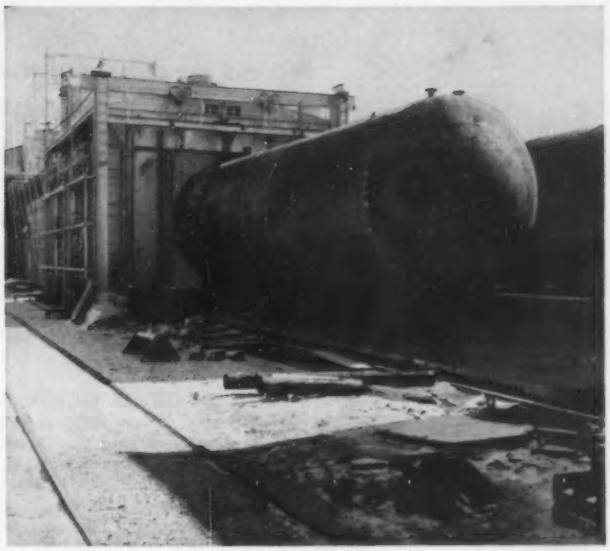
Milton E. Mohr, formerly vice president and director of the Control Systems division, has been named vice president, engi-

AVONDALE

completely equipped to meet your specifications in steel

Avondale is equipped to give you the best yet most economically fabricated products made today. Shown is Avondale's heat treating furnace—one of America's largest —in the process of stress relieving a 94′-0″ by 12′-0″ liquid cargo tank. Avondale has the greatest cross-section of precision tools in the South, able to meet your most exacting requirements.

Write for our illustrated brochure, Heavy Steel Fabrication, Vol. 3.



AVONDALE

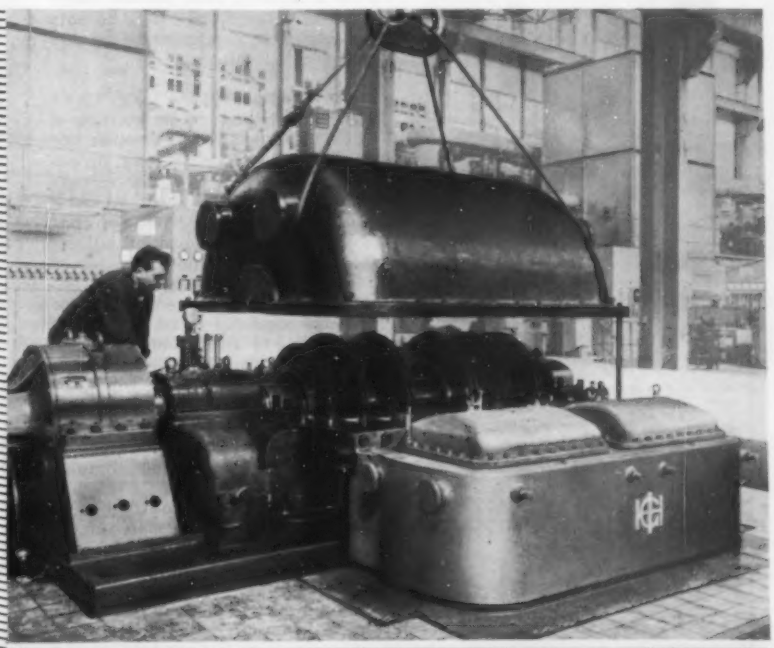
MARINE WAYS, INC.

VERSATILE BUILDER ON THE MISSISSIPPI

P. O. BOX 1030 • PHONE UNiversity 6-4561 • NEW ORLEANS 8, U. S. A.

The extensive fabrication programme of our Mechanical Engineering Division comprises among others

COMPRESSORS
BLOWERS
GAS CIRCULATORS
COLUMNS
HEAT EXCHANGERS
PRESSURE VESSELS
STORAGE TANKS



GUTEHOFFNUNGSHÜTTE

STERKRADE AKTIENGESELLSCHAFT · STERKRADE WORKS · GERMANY

REPRESENTATIVES: **THE FORAM CORPORATION**
50 BROAD STREET, NEW YORK 4, N.Y. Telephone: WHitehall 3-8241

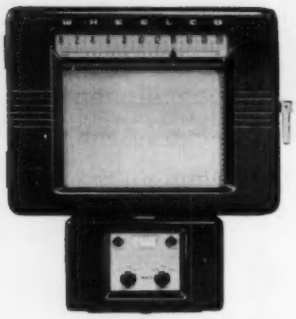
For more data on advertised products, use Readers' Service Cards, last page.

THE MARK OF QUALITY

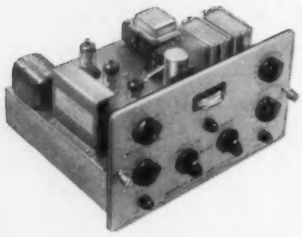
BARBER COLMAN

Wheelco Instruments

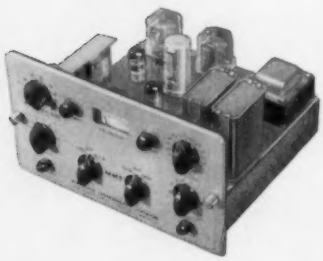
Need proportional reset and rate action? Choose from four controller types – that include magnetic modulation – by Wheelco



Start with this production-proved Wheelco Series 8000 recorder-controller and add the MM Series controller* from four types (three magnetic modulated) available to insure getting the best installation for your needs. This customizing of systems at standard cost is another example of Wheelco's constant effort to improve performance while holding down costs. Advance design features include plug-in components and tamperproof covers to protect critical adjustments.



MMC-Current Output Type—Flexible in adaptation to final control elements including saturable reactors, electropneumatic transducers, electro-hydraulic transducers, etc. . . . proportional band adjustable from 2 to 200% of controller range . . . reset action from 0 to 63 repeats per minute . . . rate action adjustable from 0 to 5.5 minutes.



MMP Position Type—Together with potentiometer can position a valve, valve positioner, or other positioning device . . . reset action adjustable from 0.6 to 100 repeats per minute . . . proportional band adjustable from 2 to 200% of controller range . . . rate action adjustable from 0 to 5.5 minutes.

MMD Duration Type—With potentiometer regulates input by adjusting on-time of a contactor on either electrical or fuel-fired installations . . . particularly adaptable when upsets are fast and recovery slow and when they are frequent and of large magnitude . . . keeps overshoot at startup or control point to minimum.

MP Proportional Positioner—Transistorized and printed circuit unit (not shown) where constant voltage source is available as reference voltage . . . mounts inside instrument . . . adjustable from 2 to 40% of recorder range.

*Also usable with Wheelco 2000 and 9000 Series.

BARBER-COLMAN COMPANY

Dept. I, 1597 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. I, Toronto

Suppliers . . .

neering, and will be responsible for the Control Systems division, Communications division and the Electronic Instrumentation Co.

Irwin A. Binder, vice president, manufacturing, will have direct responsibility for activities of the Manufacturing division.

CRANE CO., in a reorganization of its Sales division, has named **William B. Gilmour** general manager of merchandising, and **Darrell R. Nordwall**, general manager of sales.

Gilmour was with Inland Steel Co. for 22 years in sales, and since 1950 had been manager of its Commercial Research division.

Nordwall formerly was manager of Crane Co.'s west coast sales district. He will manage and control the company's field sales activities, direct the activities of its district managers, and the managers of wholesaler and customer relations.

Robert E. Penney, manager of Crane's Los Angeles branch, succeeds Nordwall as district manager.

KAISER STEEL CORP. has appointed **Augustus P. Farnsworth, Jr.**, assistant manager of plate, shape and bar sales at the firm's general sales office in Oakland, Calif.

Farnsworth has been with Kaiser's Sales department since 1950, most recently as a sales representative at the company's Southern District sales office in Los Angeles. He is a graduate of Dartmouth College.

THE A & A SUPPLY CO., Abilene, Texas, has been named area representative for the Electric Motor division, A. O. Smith Corp. A & A Supply will represent the manufacturer in West Texas.

AMERICAN CYANAMID CO. has appointed **A. J. Weith, Jr.**, commercial development manager for the Organic Chemicals division, an industry advisor to the Chemical and Rubber division, Business and Defense Services Administration, U. S. Commerce Department, Washington, D. C. A graduate of Duke University, he has been with Cyanamid since 1947 when he joined the company as a research chemist at the Stamford, Conn., Laboratories. For more than five years he served Cyanamid's Industrial Chemicals division in technical capacities. In 1952 he joined the Petrochemicals department, Organic Chemicals division, becoming departmental sales manager in 1956.

HOUDAILLE INDUSTRIES has completed negotiations and is purchasing for cash, all of the capital stock of Provincial Engineering Ltd., of Niagara Falls, Ontario.

W. F. Walker is vice president-general manager. Other officers are **Eldridge F. McRae**, assistant general manager; **Leonard Neal**, secretary; **Don A. Cobban**, comptroller.

CHASE BRASS & COPPER CO. has appointed **Ralph E. Herzler, Jr.**, aluminum specialist. He will make his headquarters in the Chase Chicago office.

Herzler was with Aluminum Company of America from 1940 to 1945, following his graduation from the University of

Suppliers . . .

Illinois where he received a B.S. degree in metallurgical engineering. He joined the Reynolds Metals Co. in 1946, where he remained until now.

FOR SALE

Specify SAUEREISEN
ACIDPROOF CEMENTS—COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna

When you see a large chimney think of Sauereisen Cements.

STAINLESS PRECISION TOOLS

Stainless Steel T-Squares, Triangles, Straightedges, and Precision Drawing Instruments and Scales. Circular and Linear Engraving to order.

CATALOG ON REQUEST

THEO. ALTENEDER & SONS
Since 1850
1221 Spring Garden Street
Philadelphia 23, Pa.

If You Want

Fast

Results . . .

Use

Petroleum

Refiner

Classified Ads

They don't cost,

they pay.

Petroleum Refiner Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads, set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All Classified ads payable in advance. Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

HELP WANTED

OPPORTUNITY FOR REFINERY MANAGER

Unusual opportunity at our new Sewaren, New Jersey refinery for a seasoned refining executive who has had at least ten years operating and administrative experience. Must have initiative, drive, and capacity to direct all phases of complete 45,000 barrels per day refinery operation. Petroleum or chemical engineering background preferred. All information confidential. Salary commensurate with ability and experience. Forward resume describing education, operating experience, and salary requirement to:

Mr. Leon Hess
HESS TRADING & TRANSPORT, INC.
P. O. Box 631
Perth Amboy, New Jersey

"We have served technical men and the refining industry since 1947."

DIXIE EMPLOYMENT SERVICE
505 South Coast Building
Houston, Texas

OPENING FOR REFINERY SHIFT FOREMAN

Newly constructed oil refinery at Sewaren, New Jersey has openings for several shift foremen. Applicants must be experienced in supervising hourly employees working on refinery units and have general knowledge of processing operations and refinery equipment. All information confidential. Salary commensurate with ability and experience. Forward resume to Personnel Manager indicating work experience, education, and salary requirement:

Hess Trading & Transport, Inc.
P. O. Box 631
Perth Amboy, New Jersey

OPENINGS FOR REFINERY-INSTRUMENT MECHANICS

Newly constructed independent oil company refinery at Sewaren, New Jersey has openings for instrument mechanics. Applicants must be experienced and capable of servicing and maintaining pneumatic, mechanical, electrical and electronic equipment. Send resume to Personnel Manager:

Hess Trading and Transport, Inc.
P. O. Box 631
Perth Amboy, New Jersey

TEXAN EMPLOYMENT BUREAU

"If you Need One—we will find one"
Specializing in engineering and technical personnel.

Should you find it necessary, I am capable of giving an aptitude test for *any* of your prospective employees.

STERLING B. DAVIS, Ph.D.
4114 Fannin Street JA 6-3291

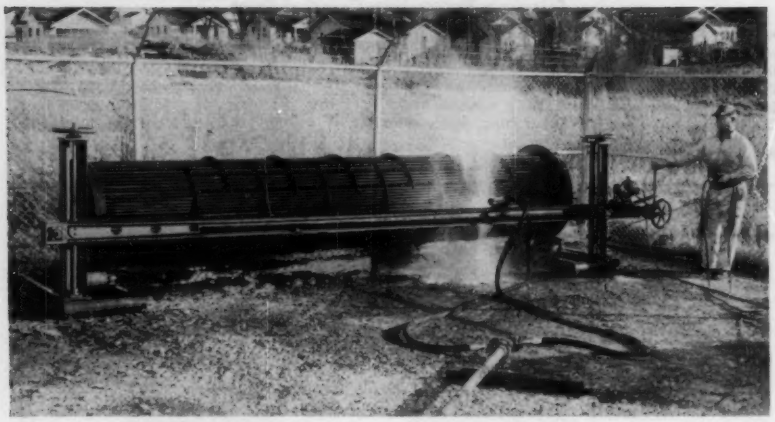
OPENING FOR PROCESS SUPERINTENDENT

New refinery at Sewaren, New Jersey has opening for Process Superintendent. Excellent opportunity for experienced individual who has ambition and ability. Applicant should have ten years refinery operating experience. Chemical engineering education preferred. All replies handled in confidence. Salary commensurate with ability and experience. Forward resume describing work history, education, and salary desired to:

Mr. Leon Hess
HESS TRADING & TRANSPORT, INC.
P. O. Box 631
Perth Amboy, New Jersey

What's New in Equipment . . .

. . . and Manufacturers Literature



Hydraulic jet head moves along supporting channel.

Jet head cleans bundle in an hour.

Tool Gets Exchanger Bundles Cleaner

High velocity water jets are used to remove deposits from badly fouled bundle tubes

A new high-pressure hydraulic tool has solved many of the problems refiners encounter in attempting to clean heat exchanger bundles. This tool removes deposits from bundle tubes by mechanical action of high-velocity water jets.

Previous methods of cleaning heat exchanger bundles have been costly, time-consuming, and often inadequate. Although light deposits can be removed simply by washing, most tube deposits cannot be readily removed. Refineries have used laborious hand cleaning methods such as vat soaking, rodding, and sawing. Chemical cleaning methods have been impractical in many cases because of inadequate inlet and outlet ports and baffles, and because many organic deposits cannot be removed with economical, nonhazardous solvents.

The bundle cleaner consists of two bases between which extends a movable beam supporting the hydraulic jetting head. This jet head is mounted on a trolley that is propelled along the supporting channel beam by a motor.

Each of the bundle cleaner's two base units has a pair of flanged rollers on which the bundle being cleaned rests. These rollers permit the bundle to be rotated so that it can be jetted from different directions. The flanged rollers can be positioned at various distances from the jet head to accommodate bundles of different diameters.

In operation, an electric motor moves the trolley-mounted hydraulic jet head back and forth along the beam. The motor also raises or lowers the entire beam assembly either 1¼ or 2½ inches during each round trip of the trolley from one end of the beam to the other.

A bundle four feet in diameter and 16 feet long was covered with deposits consisting primarily of iron oxides, with some hydrocarbons. One pass or cleaning cycle by the high pressure jetting tool from each of four directions thoroughly cleaned the bundle. Total jetting time was slightly more than one hour.

Another bundle had deposits of fairly loose dry material. The bundle was 18 inches in diameter and 20 feet long. Pitch of the brass tubes was so close that it was impossible to insert a knife blade between them. Therefore, it was exceedingly difficult for the refiner to clean. The high-pressure jetting tool cleaned the bundle so thoroughly that the cleaned tubes were a bright brass color.

A slurry reboiler exchanger bundle, 3 feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. One pass from each of four directions cleaned the bundle thoroughly.

Three rectangular bundles, 5 feet high, 1 foot wide, and 16 feet long, were cleaned. The cleaning service was so effective that the refiner commented that these bundles were cleaner than they had been in the past 13 years.

A bundle 3 feet in diameter and 16 feet long, fouled with grease deposits, was jetted from four directions, two times in succession. It was completely cleaned except for a few spots of grease splattered by the jet stream.

An eastern refiner had several bundles 3 feet in diameter and 16 feet long which were severely fouled with coke and asphalt deposits. The last time the refiner attempted to clean one of these bundles, it was necessary, after expensive cleaning efforts, to discard the bundle. One of these bundles was jetted with the bundle cleaner. The refiner had sawed out deposits around the first few rows from one direction. After this bundle was jetted for about eight hours, it was 95 to 98 percent clean. This is a degree of cleanliness that previously had not been attained on these bundles. Dowell Division of The Dow Chemical Co.

Circle E1 green card, last page

Steam Trap Manual Covers Engineering Requirements

A new 40-page engineering manual for assisting the engineering and maintenance profession in the sizing, specifying, selection and buying of steam traps and other fluid specialties, has just been published.

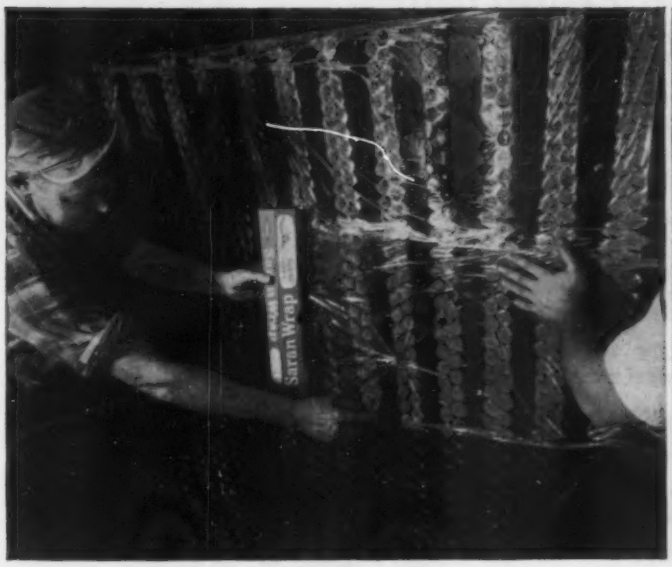
The booklet is unique among catalogs in that it is primarily an engineering manual. The first 23 pages are devoted to well-prepared technical information. All the data necessary to engineer a trap installation is included such as, (1) a steam trap selection guide; (2) an explanation of the four basic types of traps and how each perform their function; (3) the four steps to follow in sizing a steam trap; (4) table of factors and (5) detailed instructions on how to select steam traps for over 45 major classes of equipment

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBE EDITION

Plastic Film Detects Condenser Tube Leaks Without Turbine Shut Down



Maintenance crew spreads plastic film over still-wet tube sheet—a simple, fast operation.

Leaking tube is quickly identified when vacuum inside condenser sucks in plastic film.

A novel and successful method of finding and plugging leaking condenser tubes while the unit is on the line has been developed by operating personnel at the Portsmouth Power Station of Virginia Electric & Power Company, Portsmouth, Virginia. Because this simple method is inexpensive, accurate, and timesaving, it will be of interest to every engineer.

The necessity of a complete shut down to detect a condenser tube leak has now been eliminated and it is possible to take out one half of the condenser successfully, find the leak and return to full capacity 60% sooner than ever before. The key is a plastic film leak detector.

When a tube leak becomes apparent, the condenser is "shot" with sawdust until the leak becomes too difficult to control. At this point the necessary drop in load is scheduled to remove one half of the condenser. Then the condenser is backwashed before taking it off the line to make the leak reappear.

After the circulating water has drained from the leaking half, three operators go into one end of the condenser and cover the entire tube sheet with plastic film. This is most desirable while the sheets are wet. When one end is completely covered, the process is repeated at the other end of the condenser. As vacuum is built up in the leaking tube, the plastic is pulled into that tube showing immediately which tubes are the "culprits." This method has been used many times, returning the condenser to service with one or more tubes plugged and as yet no leak has gone undetected.

Virginia Electric & Power Company's plastic film "leak-detector" method is an ingenious contribution to condenser and heat exchanger maintenance. It is one of many ideas that Bridgeport Brass has brought to the attention of engineers to insure better, more efficient, more economical operation.

Your Bridgeport Salesman — backed by Bridgeport's Technical Service Staff — is continually in contact with the most recent developments in your field. He is always ready to assist you in problems involving the selection, application and use of condenser and heat exchanger tubes. Call him today.

Bridgeport **BRIDGEPORT CONDENSER TUBES**

Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal

For more data on advertised products, use Readers' Service Cards, last page.

COST REDUCTION* AND INCREASED PERFORMANCE

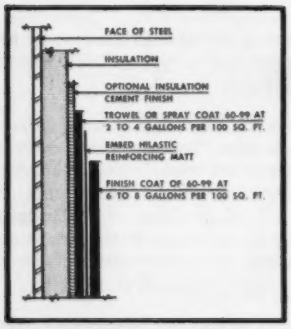
with *hi*LASTIC mastic and matt for Thermal Insulation Protection

REDUCE

1. DRIED FILM THICKNESS
2. MASTIC APPLICATION COST
   (HiLastic—first fibrated emulsion mastic suitable for spray application)
3. RE-INFORCING MEMBRANE APPLICATION COST
   (HiLastic Matt . . . flexible and easily imbedded. No re-inforcing imprint.)

INCREASE

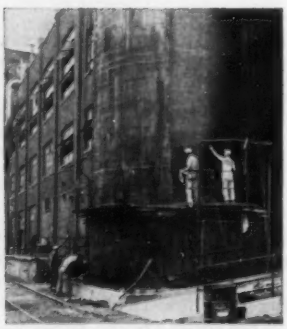
1. FLEXIBILITY
   Eliminates expansion cracks
2. RESISTANCE TO PHYSICAL ABUSE
   New concept of flexible reinforcing membrane gives added strength to mastic film.
3. DURABILITY
   Weathering resistance improved with less film thickness.


FACE OF STEEL
INSULATION
OPTIONAL INSULATION
CEMENT FINISH
TROWEL OR SPRAY COAT 60-99 AT 2 TO 4 GALLONS PER 100 SQ. FT.
EMBED HILASTIC REINFORCING MATT
FINISH COAT OF 60-99 AT 6 TO 8 GALLONS PER 100 SQ. FT.

Application drawing is not made to scale.

HERE'S HOW

HERE'S RESULT



Foster HiLastic Mastic and Matt as applied to tower at The Mead Corporation plant, Chillicothe, Ohio.

*Actual job figures available with insulation contractors indicate 25% to 35% reduction in cost of applied mastic finish.

foster COATINGS • SEALERS • ADHESIVES for thermal insulation

BENJAMIN foster CO.
Division of Amchem Products, Inc.
4635 W. GIRARD AVE. • PHILA. 31, PA.

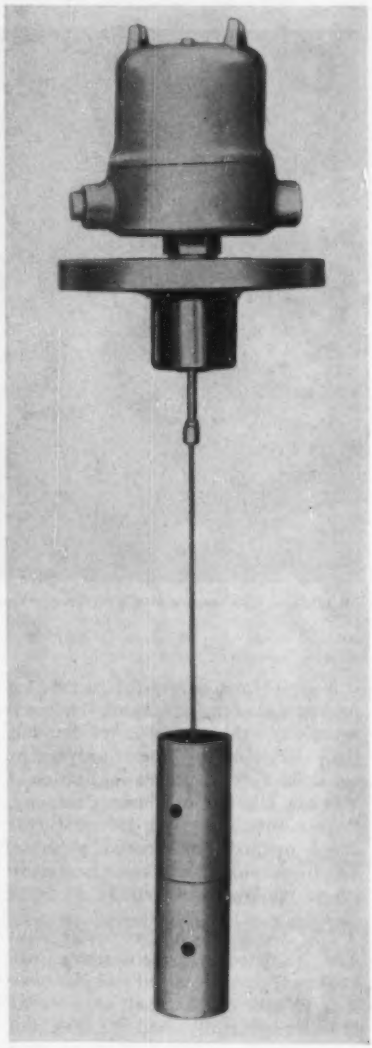
SOLD BY AMERICA'S LEADING INSULATION DISTRIBUTORS AND CONTRACTORS

New Equipment . . .

in practically every industry using steam.

In this engineering section are also 26 piping details showing the correct method of installing traps for a wide variety of applications. These details clearly show the location of traps, valves, strainers, unions and related fittings and are ideal for use by the draftsman, specifying engineer or the maintenance engineer. A dozen tables make it easy to select traps for various sizes of equipment in a matter of minutes. The V. D. Anderson Co.

Circle E2 green card, last page



Liquid Level Controllers Feature Narrow Differential

Precise control of liquid level is obtained with new type single-stage, narrow-differential liquid level controls. Small movement between make-break contacts provides high sensitivity to level change.

A greater number of liquids can be controlled with the new-design instruments—liquids of specific gravity 0.30 and

OPTIMUM DESIGN...

of YUBA HEAT EXCHANGERS achieved by COMPUTER SYSTEM

Into Yuba's Central Computer System go the temperatures and pressures your heat exchangers must handle, flow quantities and fluid properties, tube layout, allowable pressure drop, and nozzle connections.

Out comes the number in series, shell size, minimum number of segmental baffles, optimum number of tube passes, calculated pressure drop, heat transfer rate on both shell and tube sides, and the corrected LMTD. Elapsed time: 15-20 minutes with the computer as compared to days with the slide rule.

No guesswork! Optimum results with absolute accuracy. Also...we can extract from the Yuba Computer System all kinds of alternates for you: alternate flow quantities, alternate temperatures, and alternate tube construction (fin or bare). This central computer system is used by all Yuba divisions manufacturing heat exchangers.

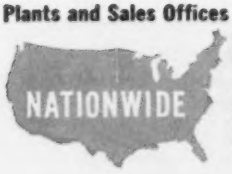
YUBA HEAT TRANSFER DIVISION, Honesdale, Pa.; ADSCO DIVISION, Buffalo, N. Y., and YUBA MANUFACTURING DIVISION, Benicia, Calif.

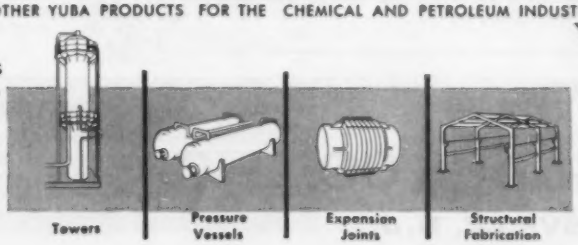
YUBA CONSOLIDATED INDUSTRIES, INC.

OTHER YUBA PRODUCTS FOR THE CHEMICAL AND PETROLEUM INDUSTRIES.

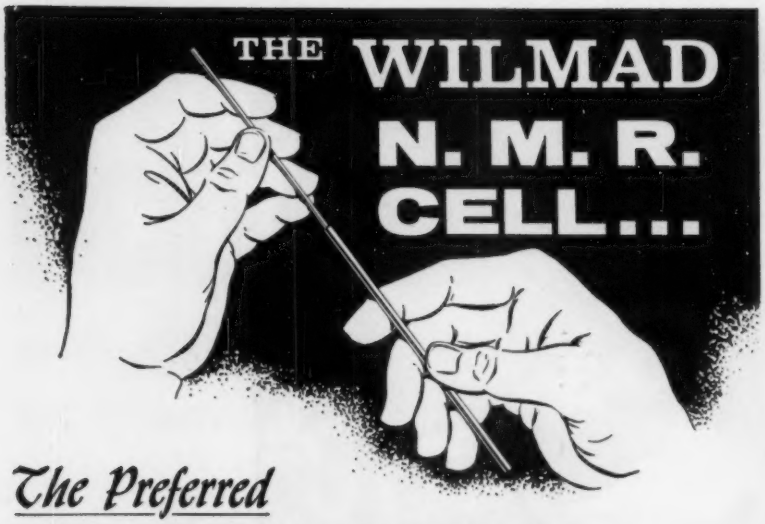
YUBA

Plants and Sales Offices





For more data on advertised products, use Readers' Service Cards, last page.



The Preferred

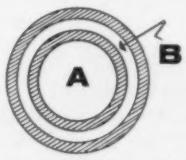
GLASS COAXIAL SYSTEM FOR EXTERNAL REFERENCING OF N. M. R. HIGH RESOLUTION SPECTRA

The advantages of external referencing procedures in nuclear magnetic resonance high resolution spectroscopy can now be fully realized through the use of the Wilmad NMR Cell. It is the only cell to give consistently reliable results in the coaxial spinning system.

The coaxial spinning system was developed for external referencing procedures in order to subject the sample and the standard to a common effective external magnetic field. It was found, however, with this system that imperfections in the coaxial glass tubes caused line broadening and field shifts which impair the reliability of results. Certain line broadening phenomena occurred due to the imperfections in standard glass tubing. Experimental measurements also show that even in selected standard glass stock, field shifts were often as large as 1 part in 10^7. But by utilizing the extreme precision of the Wilmad NMR Cell, line broadening and field shifts were negligible.

For details on the coaxial spinning system, write for the American Chemical Society paper, "Standardization of N.M.R. High Resolution Spectra" by Dr. J. R. Zimmerman and M. R. Foster.

The coaxial spinning system consists of two precision glass tubes mounted coaxially in a spinning apparatus. The sample is placed in the inner tube (A) and the reference standard is placed in the region between the two tubes (B). In this manner, both the sample and the standard can be subjected to a common external magnetic field. Imperfections in the glass can cause error. Spinning the tubes rapidly helps limit the errors, but even then all particles do not experience the same average field. Only with the perfection of the Wilmad NMR Cell do errors attributable to the glass become negligible. The air-propelled spinning device designed to rotate the coaxial cell at 5000 r.p.m. is also available from Wilmad Glass Company.



THE COAXIAL NMR CELL IS MANUFACTURED EXCLUSIVELY BY WILMAD GLASS COMPANY UNDER A LICENSING AGREEMENT WITH MAGNOLIA PETROLEUM COMPANY.

WILMAD GLASS CO., INC.

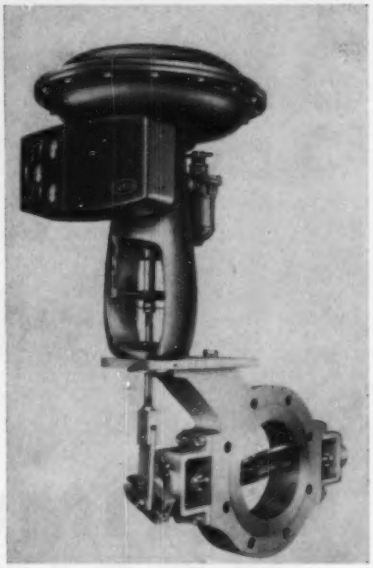
LANDISVILLE, N. J.

New Equipment . . .

up, temperatures to 500 F., pressures to 5000 psi.

Displacers are available in many materials—including Karbate, porcelain, stainless steels. With stainless steel displacers, interface applications are also possible. Magnetrol, Inc.

Circle E3 green card, last page



Butterfly Valve Features Rugged Actuator Mounting

Major advances in butterfly valve design have just been announced. These have been incorporated in the new 32,000 series of wafer-type Butterfly Valves, now being offered by the company for the first time on a national basis.

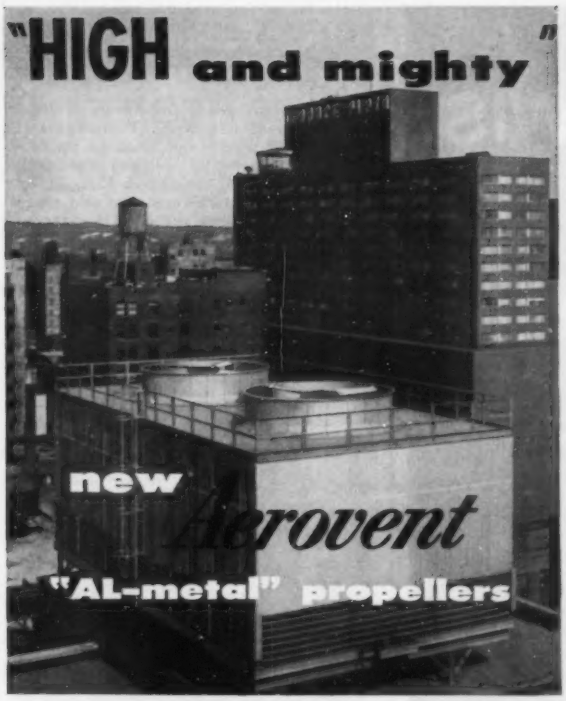
Outstanding features of the new butterfly valve line are said to be ruggedized actuator mounting, ease of adjustment, accessibility and maximum actuator power delivery. A special actuator mounting plate has been designed which provides maximum support and makes it possible for the actuator to be adjusted along a slotted plate so that actuator may be precisely positioned to deliver maximum power with minimum angularity. This enables the connecting stem and link to be in line and at right angles to shaft arm at mid-stroke, for either 60 F. or 90 F. (or any intermediate point) operation.

In addition, maintenance is greatly simplified by oversized bearing brackets which permit easy access to the packing box and removal of the self-centering packing gland follower and gland to insert additional packing, without disconnecting linkage or detaching brackets. Mason-Neilan, a Division of Worthington Corp.

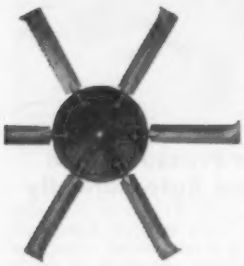
Circle E4 green card, last page

Paper Describes Alloy Used For High Temperature

Engineers and those associated with the design and operation of steam generating equipment will be interested in Bulletin TR-555, a reprint of a technical paper entitled, "Croloy 15-15N—an Austenitic



move mountains - of AIR!
in towers and exchangers



- Sizes 14′ to 18′
- 4 or 6 blades

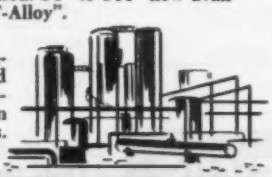
Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

Write for free Bulletin 510

DESIGNED FOR DEPENDABLE OPERATION!

Endurance tests, conducted at 3 *times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in revolutionary new "T-Alloy".

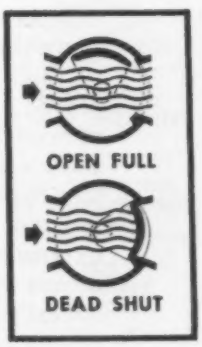
REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



Aerovent FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg.
TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO

NO OTHER VALVE can give you the advantages of DeZurik's EXCLUSIVE Eccentric Action in combination with resilient-faced plugs. NO OTHER VALVE can give you *tighter shut-off—easier operation—WITHOUT LUBRICATION!*

DeZurik's exclusive eccentric action pivots the plug eccentrically, matching an eccentrically-raised seat. The plug touches the body *only* when the valve is shut. In opening the valve, the plug backs away from the seat and swings aside in an easy quarter turn . . . without friction, without binding, WITHOUT LUBRICATION!

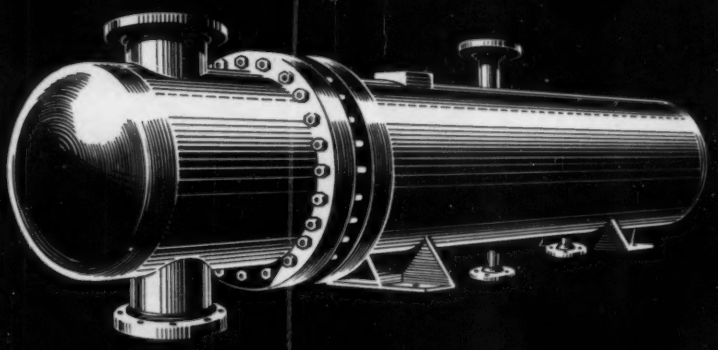


DeZurik Valves are available in sizes ½″ thru 20″ in many metals and models with a full range of operators. See the DeZurik representative in your area, or write for details.

DeZURIK CORPORATION
SARTELL, MINNESOTA

For more data on advertised products, use Readers' Service Cards, last page.

MANNING & LEWIS



M & L CARBON STEEL REACTIVATION CHILLER made to A.S.M.E. code. (Dimensions 18" outside diameter shell, 7' overall length, weight 2000 pounds).

Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

It is impossible, in a field requiring such wide diversification, to illustrate, or even list, all the products we have been called upon to supply. The chiller above is simply one among thousands.

Call on us the next time you need equipment. We are fully qualified to design and fabricate to all codes.

M&L MANNING & LEWIS

ENGINEERING COMPANY

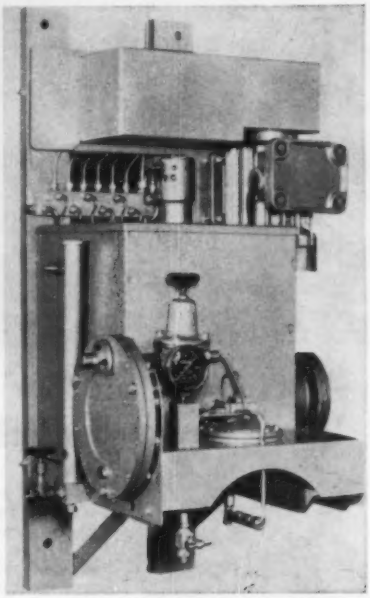
Dept. C, 28-42 Ogden Street, Newark, New Jersey

DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT

New Equipment . . .

Heat Resistant Alloy for Severe Tubular Application at Elevated Temperatures." This 11-page reprint describes the involved testing program and outlines the many characteristics of Croloy 15-15N. It explains why the creep-resistance and creep-rupture strengths of the alloy are far superior to austenitic heat resistant alloys presently used in the 1,200-1,500 F. temperature range. The Babcock & Wilcox Co.

Circle E5 green card, last page



Reid Vapor Pressures Can Be Recorded Automatically

The Reid Vapor Pressure Recorder (shown above) when coupled directly to the control of a fractionating column is expected, by refinery engineers, to result in a saving of the equipment, capital cost in approximately the first three weeks of operation.

The automatic recorder simulates, as accurately as possible, the conditions occuring in the standard hand apparatus so that the values obtained are indeed true Reid Vapor Pressures.

The instrument is available in two standard forms, for single point and twin point sampling. It can record at intervals of either twenty or thirty minutes, thus giving two or three records per hour on the single point model, or a record every 40 or 60 minutes on each line of the twin point instrument. Nash and Thompson, Ltd.

Circle E6 green card, last page

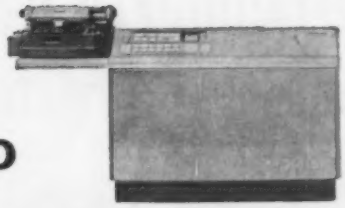
Most Active Flocculant On Unit Weight Basis Available

A new, high-activity, polyacrylamide-type flocculating agent, Separan NP20, has been added to the company's flocculants. Separan NP20 is "the most active material available on a unit weight basis," the announcement said.

"This means that less flocculating material may be used, or the same amount of

TODAY'S GREATEST VALUE IN ELECTRONIC COMPUTERS!

ROYAL PRECISION LGP-30



Compare it, feature by feature, with the other computers in its class

Feature	Computer A	Computer B	Computer C	Computer D	LGP-30	
Memory Size	220 words for data only	2160 words	1000 or 2000 words	84 words for data only	4096 words for data & program (either or both)	LARGEST CAPACITY IN ITS CLASS
Max. Speed Add Multiply	 20/sec. 4/sec.	 Comparable to LGP-30	 Comparable to LGP-30	 3/sec. 1/sec.	 Over 440/sec. Over 50/sec.	SPEED EQUAL TO MANY ROOM-SIZED COMPUTERS
Size	17 sq. ft.	6.5 sq. ft. plus table for typewriter.	45 sq. ft.	9.2 sq. ft. plus table for typewriter & control unit.	11 sq. ft.	COMPACT, DESK-SIZED, COMPLETELY MOBILE
Input-Output	Keyboard only — tape at extra cost.	Independent tape preparation at extra cost.	Extra cost peripheral equipment required.	Tape and typewriter for numerical input-output only. Independent tape preparation at extra cost.	Tape typewriter for alpha-numeric input-output standard equipment.	DELIVERED COMPLETE. NO ADDITIONAL EQUIPMENT NEEDED TO PREPARE DATA, PROGRAM OR REPORTS
No. of tubes	165	450	2,000	248	113	FEWER COMPONENTS MEAN LESS MAINTENANCE, FEWER CHECKOUTS
Voltage	220 V	110 V	220 V	110 V	110V	PLUGS INTO ANY REGULAR WALL OUTLET
Power	2.5 KW	3.0 KW	17.7 KW	1.65 KW	1.5 KW	NO SPECIAL WIRING OR AIR-CONDITIONING REQUIRED
Ease of programming & operation	Not alpha-numeric. No internal program storage.	Alpha-numeric at extra cost. 8 part instruction. Requires computer specialist.	Alpha-numeric at extra cost. Requires computer specialist.	Not alpha-numeric. No internal program storage.	Alpha-numeric. Complete internal program storage. Standard typewriter keyboard. Simplest command structure of all.	EASY TO PROGRAM AND OPERATE.
Cost Sale Rental	 $38,000 $1000/mo.	 $49,500 $1485/mo.	 $205,900 $3750/mo. up	 $55,000 $1150/mo.	 $49,500 $1100/mo.	LOWEST COST EVER FOR A COMPLETE GENERAL PURPOSE COMPUTER

Nation-wide sales and service. Trained staff of applications analysts. Library of subroutines available, plus programs for wide variety of applications.

For further information and specifications on Royal Precision LGP-30, call your nearby Royal McBee office, or write Royal McBee Corporation, Data Processing Division, Port Chester, N. Y.

ROYAL McBEE

WORLD'S LARGEST MANUFACTURER OF TYPEWRITERS AND MAKERS OF DATA PROCESSING EQUIPMENT

For more data on advertised products, use Readers' Service Cards, last page.

"drop test" proves greater strength of **STANCO** *Ductile Iron Valves...*

Dropped from a height of 40 feet, a 3,000 pound weight destroyed an ordinary cast iron valve body, yet barely dented a STANCO Ductile Iron Body — proof positive of the greater strength of STANCO Ductile Iron Works.

Greater strength, however, is just one of the many unique advantages of STANCO Ductile Iron Valves. They possess corrosion resistance equal to that of cast iron, elevated temperature strength comparable to that of ordinary cast steels, and thermal shock resistance equal to that of cast carbon steels. And they are *pressure tight* — ductile iron has a metallographic structure which resists leakage or seepage by liquids and gases.

Rigid Quality Controls Assure Long Service Life

Every step in the manufacture of STANCO valves is carried out under one roof. From the patterns through the various stages of casting, heat-treating, machining, assembly and testing, Standard Brass and Manufacturing Co. provides a single, undivided line of responsibility.

These revolutionary valves are making possible substantial savings for many users. May we send you complete information?

Trade Mark of the International Nickel Co.

STANDARD BRASS & MANUFACTURING CO.

Home Office and Plant — Fourth & KCS Tracks
Port Arthur, Texas

DISTRICT OFFICES AND WAREHOUSES

TEXAS: Houston — 2018 Franklin • Beaumont — 705 Milam
LOUISIANA: New Orleans — 4701 Palmetto • Shreveport — 2135 McCellan • Lafayette — 819 Oak Avenue

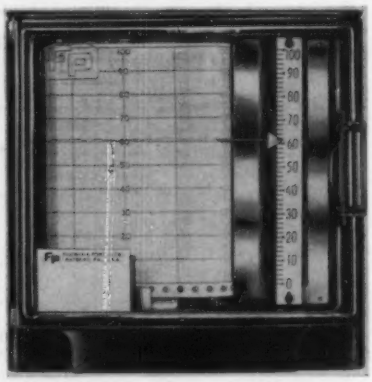
DISTRICT SALES OFFICES: Corpus Christi — IBM Building • Baton Rouge — 3160 Florida

New Equipment...

material will provide more flocculating activity in a given application."

The new material is now available in commercial quantities. It is a synthetic, organic, water-soluble, high molecular weight polymer which is manufactured as a white amorphous flake. It has uniform effectiveness over a wide pH range. The Dow Chemical Co.

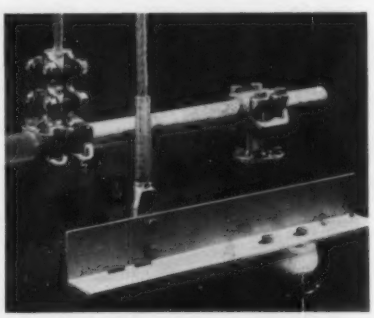
Circle E7 green card, last page



Miniature Instruments Have Plastic Doors Available

A Ratographic line of miniature indicating, recording and controlling instruments is now available with optional plastic or metal doors. Plastic doors provide superior visibility and are gasketed to keep out dust, dirt and harmful vapors. All features of the miniature instruments are retained; plug-in construction permits interchangeability of chassis without interruption of process; chassis can be withdrawn to the "inspection position" exposing 14 hours of chart record and providing easy accessibility to all adjustments without disturbing operation; controllers can be plugged into rear manifold; four-inch wide linear strip chart provides maximum readability. Fischer & Porter Co.

Circle E8 green card, last page

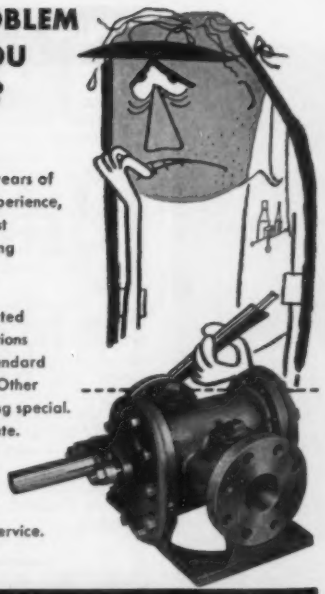


Aluminum Used For Low Cost Bus Conductor

A low-cost substitute for smaller sizes of tubular bus conductors now is available. It's the Universal Angle Bus Conductor.

The new product, an L-shaped extrusion, was developed to provide a bus conductor that will adapt to normal cable lug con-

PUMPING PROBLEM GIVING YOU TROUBLE?



Get *qualified* help.
Tell us about it.
SK Gear Pumps, product of years of research and engineering experience, are solving problems in almost every industrial field—pumping many types of materials like alcohol, fuel oils, glue, wax, lube oils, resins, cellulose, heated oils, road tars. Some applications require only a top-quality standard pump. Ours are top-quality. Other applications demand something special. If so, we're ready to cooperate.

We'd like to get acquainted —let us send you Bulletin 17-A describing our pumps and engineering service. Just write us. We'll send it.

Schutte and Koerting COMPANY
MANUFACTURING ENGINEERS
2257 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus: Ask for Condensed Bulletin J-1.	Rotameters & Flow Indicators: Ask for Condensed Bulletin 10-RA.	Valves: Ask for Condensed Bulletin V-1.	Heat Transfer Apparatus: Ask for Condensed Bulletin HT-1.	Gear Pumps: Ask for Bulletin 17-A.

RUGGED H_2 INDICATOR for catalytic reformers

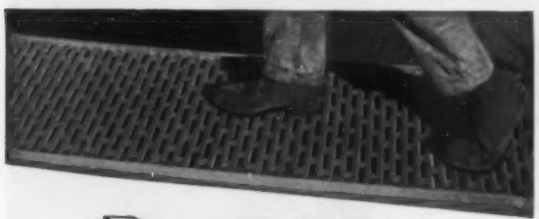
Works on a simple, mechanical principle using specific gravity to measure H_2 in reformer recycle gas. Low cost. Instant response. Local or remote readings. Replaces expensive, delicate instruments that "can't take it."

Other uses: Measuring specific gravity of refinery fuel gas, off-gases from cracking furnaces, demethanizers, etc. and for gas blending . . . also analyzing boiler and heater flue gases to cut fuel costs.

• • •

Write for Technical Bulletin RD-101, The Permutit Company, a division of Pfaudler Permutit Inc., Dept. PR-9, 50 West 44th St., New York 36, New York.

RANAREX®



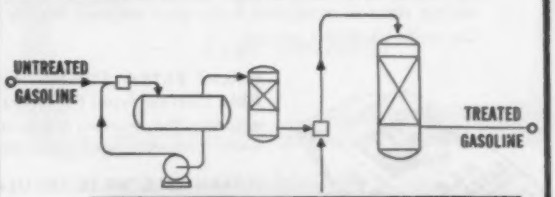
Aluminum Grating

for ramps, walkways, pit covers, floorings, etc.

Patented Upset design provides sure-footed, non-skid, non-directional safety—even in the presence of wet, greasy or other hazardous conditions. Non-magnetic, non-sparking and maintenance-free! Washington Aluminum will fabricate any shape, width or length grating to answer your most exacting requirements. low as **$2.50** per sq. ft.
FREE BOOKLET ON REQUEST.

WASHINGTON ALUMINUM COMPANY, INC.
Dept. 59 • Baltimore 29, Md. • Phone Circle 2-1000

TC SWEETENING



TENNESSEE COPPER CHLORIDE

Tennessee's Copper Chloride was developed to effect efficient Mercaptans removal.

Place your confidence in a basic producer of Copper Chemicals.

CUPRIC CHLORIDE DI-HYDRATE

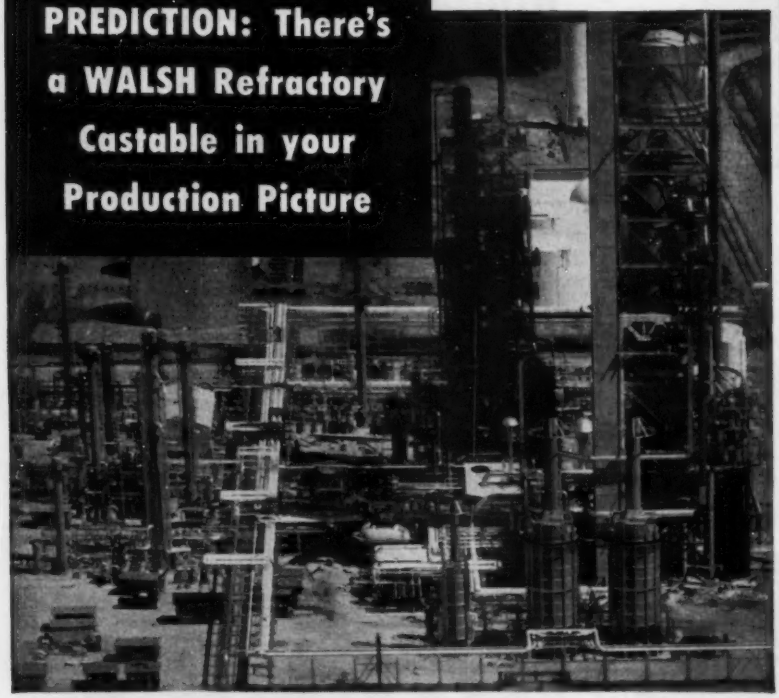
Other products of interest—
Ferric Sulfate—Copper Sulfate,
Copper Oxide—Sulfur Dioxide.

For samples make request on your company letterhead.

TENNESSEE TC CORPORATION
617-629 Grant Building, Atlanta, Ga.

For more data on advertised products, use Readers' Service Cards, last page.

PREDICTION: There's a WALSH Refractory Castable in your Production Picture



Assurance Of New Highs In Performance At Lower Cost

Whether your refractory castable practice calls for a two-component lining or consideration of a "one shot" system later on—you'll find the right Walsh product for your purpose. Modern as tomorrow, every Walsh Castable offers absolute homogeneity—the result of production control methods that insure the perfect union of all ingredients for efficient service throughout a longer life. The whole money-saving story is available from your nearest Walsh representative. Or, write us direct, today.

WALSH EXTRA STRENGTH H & B CASTABLE (Service Type) For highly abrasion-resistant, monolithic, working linings in catalytic regenerators, reactors, and other refinery equipment.

WALSH LITE WATE INSULATING CASTABLE NO. 50. Features high bulk density while retaining a low K factor. Recommended for back-up use in two-component linings.

WALSH LITE WATE INSULATING CASTABLE NO. 70. Higher strength and a low K factor makes this insulating castable highly desirable for "one shot" linings.

All Walsh Castables are characterized by extreme "flowability", excellent nozzle compaction, lower rebound loss . . . plus greater strength, better bond . . . throughout the complete temperature range.

Send for New Illustrated Castable Bulletin

WALSH
REFRACTORIES CORPORATION
101 Ferry Street • St. Louis 7, Missouri
SPECIALISTS IN REFRACTORIES OF HIGH BULK DENSITY AND LOW POROSITY

New Equipment . . .

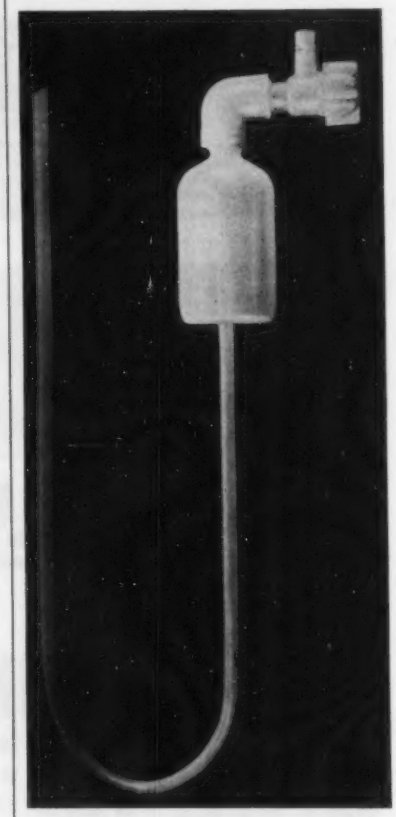
nectors. It brings new features to an old conductor shape—the structural angle.

Although used normally where current ratings are in the 700-800 ampere range, UABC in the 3¼ x 3¼ x ¼-inch size is rated at 1300 amps. Where two such angles are used back-to-back, mounted directly to insulator caps and separated ¼-inch, the resulting current rating is about 70 percent higher than for a single conductor.

On the outer surfaces of the bus, two extruded grooves locate the center points for drilling holes which receive a standard connector, or for direct connection to station apparatus. On the inner surfaces, a single groove locates the center line, so that the bus may be drilled to connect directly to insulators.

UABC is available now in the 3¼ x 3¼ x ¼-inch size in standard 25-foot lengths. Other sizes will be available, subject to demand. Aluminum Company of America.

Circle E9 green card, last page



Polyethylene Siphon Has Built-In Self-Starter

An all-polyethylene siphon with a built-in "self-starter" is now available. The siphon consists of a semi-rigid "U" tube which has an open end and a flexible "squeeze" bulb attached to the other end. The squeeze bulb has a stopcock outlet.

To operate the siphon, the user first places the open end of the "U" tube in the liquid to be siphoned. The stopcock is then closed. Squeezing the bulb primes the siphon by forcing air out of the open

METEX

MIST ELIMINATORS

(ENTRAINMENT SEPARATORS)

Eliminate product loss, cut operating and maintenance ...at low first cost

Metex Mist Eliminators have been used successfully on many applications to knock back liquid entrainment. They are used in any vessel handling liquids and vapors when complete separation of the two phases is desired. Separation efficiency of 99% + is maintained.

Ask Metex for engineering recommendations. Write today for Bulletin ME-6 and a data sheet.

METEX

6-107

METAL TEXTILE CORP.
ROSELLE, NEW JERSEY

As SIMPLE and Dependable as the Pull of a MAGNET!

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

The Simplest, Most Versatile LIQUID LEVEL CONTROL Ever Devised!

Linked to liquid level by infallible magnetic force, Magnetrol is free from the limitations inherent in mechanical or electrical controls. With the actuating magnet rated at 98% of initial strength after 30 years, Magnetrol has *infinite operating life*, with practically no maintenance at all. There are no wearing parts to get out of order.

What's more, Magnetrol's simple operating principle permits easy, economical modification of standard units to meet *any* pressure, temperature or corrosion requirements. That's why there's practically no limit to Magnetrol's use. It's also why "specials" are likely to be standard with us. Magnetrol units control level changes from .0025-in. to 150-ft. —with single or multi-stage switching.

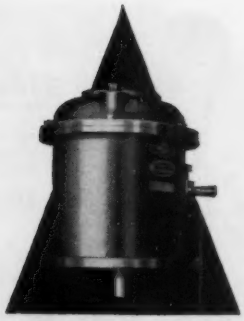
MAGNETROL, Inc.

● SEND COUPON FOR DETAILS

MAGNETROL, Inc. 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls.

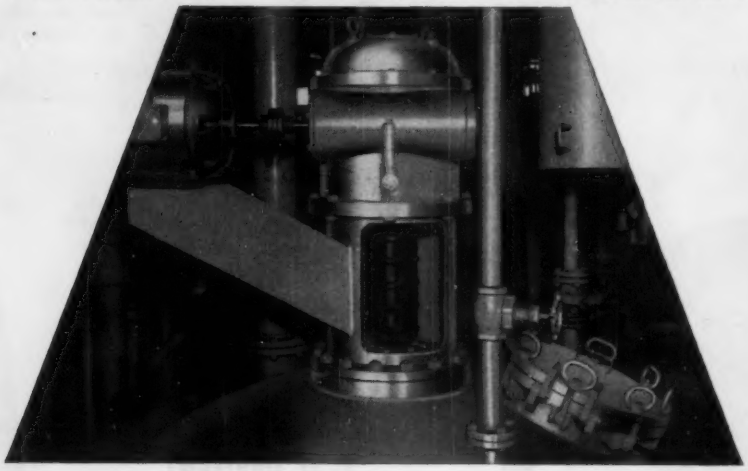
Name_____
Company_____
Address_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.



GET PRODUCT UNIFORMITY FASTER and at LESS COST

. . . with NETTCO Engineered Agitation!



INCREASE PRODUCTIVITY, lower power costs, and minimize maintenance requirements . . . with "process-rated" Model WT agitators by Nettco. Standardized components (motor, drive, shaft, stirrer) can be combined to suit your most exacting size, speed, HP or other process specifications. Check the design features of the Model WT tank top agitator . . .

- Worm gear reduction drives
- Ratios from 3.5:1 to 68:1
- Seven sizes available
- Complete range of speeds
- Minimum moving parts
- Large diameter vertical shaft
- Widely spaced, oversized Timken bearings
- Fully enclosed — dust, fume, moisture-proof
- Splash lubrication, drip-proof design
- Oil-trapped against leakage

Model T units, featuring helical gear trains and worm gears in combination, offer ratios from 6.25:1 to 100:1 in numerous "process-rated" models designed for dependable, economical operation. Ask Nettco agitation engineers for recommendations. Request Bulletin 551 and data sheet from **New England Tank & Tower Company, 81 Tileston Street, Everett 49, Mass.**

NETTCO
ENGINEERED AGITATION

FREE LITERATURE

Please send me the following literature:

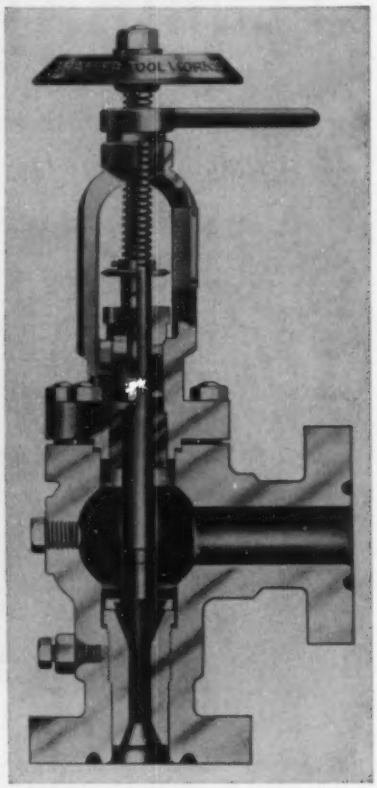
- ☐ Tank Top Agitators—Bulletin 551
- ☐ Portable & Tripod Mixers—Spec. Sheets
- ☐ Pipeline-Flomix®—Bulletin 531
- ☐ Side Entering—Bulletin 532

New Equipment . . .

end into the liquid. When the bulb is released, the partial vacuum created sucks the liquid into the open end, over the "U" bend in the siphon tube, and, when the stopcock is opened, into a waiting receptacle.

Safe and simple to use, the all-polyethylene siphon is easy to clean and practically unbreakable. It is resistant at normal temperatures to concentrated acids, oxidizing agents, hydroxides, and polar liquids. General Scientific Equipment Co.

Circle E10 green card, last page



High Pressure Throttling Valve Sizes to Six Inches

A new large, high pressure throttling valve for general industrial and chemical use is now being manufactured.

This metering valve has many features which make it ideal for accurate fluid or gas control. Outside threads give corrosion resistance and the stem may be locked at any setting. A pointer and calibration plate indicate the amount of orifice opening. A tapered throat gives a venturi tube effect with excellent flow characteristics.

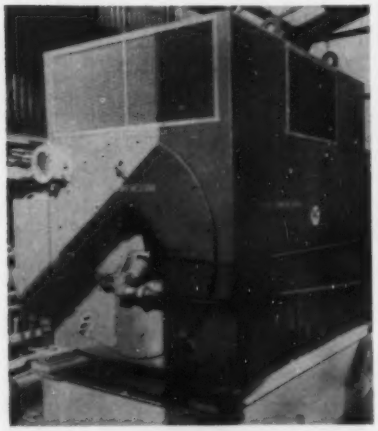
Available in ASA or API flanged or threaded connections, this valve is made in carbon steel, stainless steel, bronze or aluminum. It is manufactured in sizes one inch to six inches and in pressure ratings to 10,000 psi in all sizes.

Several interchangeable tips are manufactured: conical, micro tip (which gives equal changes of orifice area for equal stem travel), thermo tip (which has an internal heating element in the tip), and extra-hard metal tips for special abrasion

resistance. Fixed diameter chokes are available in all sizes.

Automatic actuation by hydraulic or air pressure is available on all valves. Shaffer Tool Works.

Circle E11 green card, last page



Vital Motor Parts Guarded In High HP Installations

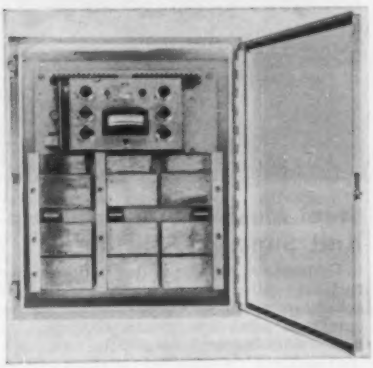
Now being successfully applied to outdoor installations in the petroleum industry is the recently introduced open-type Super-Seal motor.

Because of its unique homogeneous vulcanized coil structure, this motor makes it possible for users to forget about ambient conditions, total enclosures or special ventilating schemes at substantial cost savings.

Since the safeguarding of vital electric parts in this motor is inherent in the Silco-Flex insulation system, the machine needs no costly housing or special protective features.

One example of the use of these motors is at the Baton Rouge refinery of Esso Standard Oil Co., where Super-Seal squirrel-cage induction motors are installed. One, a 600-hp, 2300-volt, 900-rpm machine driving a pump, is completely outside. The other, a 3500-hp, 2300-volt, 1800-rpm motor driving a compressor is partially under cover. Allis-Chalmers Mfg. Co.

Circle E12 green card, last page



Computer Optimizes Tower And Column Operation

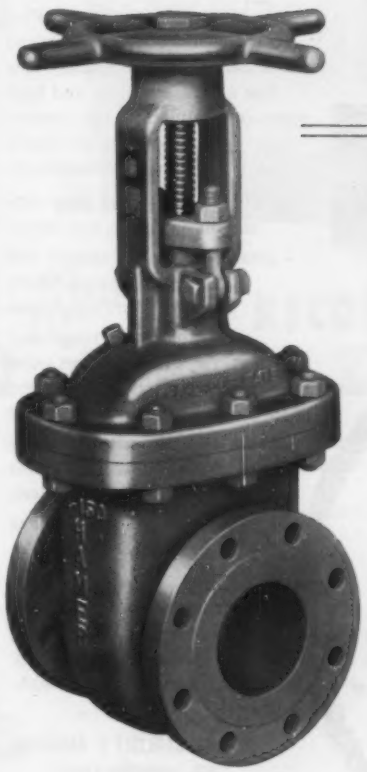
Extremely high reliability in a new series of analog in-process computers is achieved by the elimination of all vacuum tubes, relays, and servo-slidewires. These computers are used first as operational

New Hamer "Wedge Seal" LEAKPROOF GATE VALVE

"DUAL" LEAKPROOF SEALING ACTION

POSITIVE SHUTOFF UPSTREAM — DOWNSTREAM

SERVICEABLE IN THE LINE



The new Hamer *Wedge-Seal*, unlike conventional Gates, incorporates a two-way sealing action that insures absolute line shut-off even on lines handling customarily hard-to-hold fluids. As the wedge is lowered to its precision metal-to-metal fit, a Teflon* seal in each side of the wedge compresses against the seats, forming a dual bubble-tight sealing action. Yet, with all of its added sealing quality, the new *Wedge-Seal* costs little more than a regular gate. Send for literature today. See for yourself how a Hamer *Wedge-Seal* can actually pay for itself.

*RTM DuPont

Renowned for their inert characteristics, Teflon seal rings used in the new Wedge-Seal have amazing durability, can be replaced, when necessary with minimum effort.

Hamer VALVES INC.

P. O. BOX 1851
2919 GARDENIA AVENUE
LONG BEACH 1, CALIFORNIA

Representatives throughout the world

HAMER VALVES, INC.
Box 1851, Long Beach 1, Calif.

Please send immediately your Wedge-Seal Gate Valve Bulletin WS-1.

Name_____

Company_____

Title_____

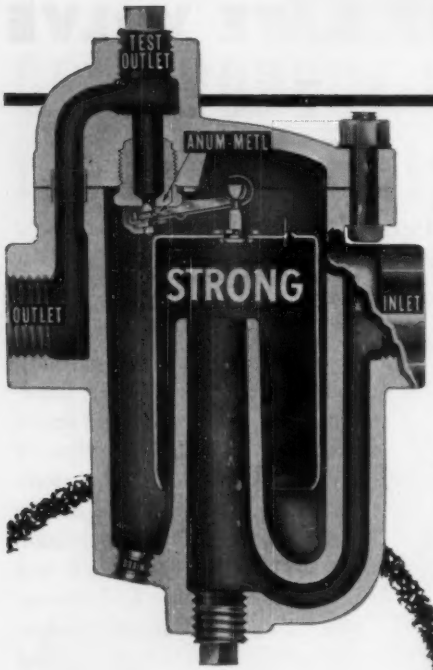
Address_____

City_____ Zone_____ State_____

58-3

For more data on advertised products, use Readers' Service Cards, last page.

HYDRO-FLEX --- we engineered this new steam trap for YOU!



☐ Install Strong Hydro-Flex steam traps with assured confidence. This completely new line of low, medium, and high pressure steam traps will operate equally well on light and heavy condensate loads.

Hydro-Flex offers these outstanding features and more:

- greater discharge capacity and efficient operation under *all* conditions
- dual fulcrum arrangement that snaps the leak-free valve wide open to give unrestricted condensate flow
- all working parts and deep-drawn bucket of durable stainless steel.
- rugged construction features assure long trouble-free service.

For complete information, contact your local Strong Distributor and write for new Bulletin No. SS-40A.

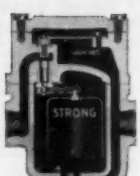
STRONG®
HYDRO-FLEX high efficiency under all condensate loads
STEAM TRAPS

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.

STRONG, CARLISLE & HAMMOND
508 SANDUSKY STREET
CONNEAUT, OHIO

BOTTOM INLET SERIES
Hydro-flex traps with bottom inlet have the same high qualities and features as horizontal types.

PRESSURE REGULATING VALVES
3 types available for wide range application . . . to meet pressure and capacity requirements.



BLAST TRAPS
Thermal types for quick air and condensate removal during rapid heating up.

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

New Equipment . . .

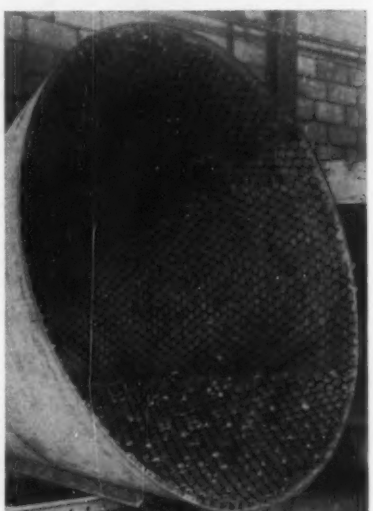
aids, and later as optimizing controllers in fractionating towers or distillation columns.

The computer accepts electrical input signals from standard instrument transmitters installed in the process loop, and performs computations designed to maintain output product at desired quality (or quantity). The basis of the calculation is the feed flow rate and product analysis, however, other inputs are readily usable. Distillation column output is computed by summing the product line flows. Input signals are converted to their logarithms, and these are then merely added, subtracted, or proportioned to compute products, quotients, or exponentials.

Magnetic amplifiers are used for operational amplifiers and aged transistors are used for any memory or switching requirements. The circuit requires no maintenance, and with no exposed contacts, it may be placed safely in an explosive area. The computer is enclosed within a moisture-proof durable steel cabinet.

The first unit delivered has been used to compute the performance of a fractionator tower for operator guidance. The next step is automatic control. These computers are also suitable for control of processes in which dynamic flow relationships must be maintained, eliminating much of the process equipment currently used in conventional static control. Southwestern Industrial Electronics Co.

Circle E13 green card, last page



Steel Mesh Prevents Slump And Supports Castables

Damage by erosion and abrasion to the castable lining of vessel walls, can be greatly reduced with "Gridsteel," a low-cost steel mesh armor and retainer now being manufactured in two types.

"Gridsteel" is attached to the shells of such vessels as cat crackers, hydroformers, reactors, regenerators, cyclones, and so on. It provides an interior surface of hexagonal, steel cells. Ganister or castable refractory is then gunned or troweled into the meshes, forming a monolithic lining.

The "Gridsteel" supports the castable material and prevents slump. It provides

a framework which will prevent the natural tendency for the lining to crack, blister, pit, or collapse under internal pressures, temperature changes, and catalytic bombardment. The life of the lining is lengthened, reducing the frequency of costly shutdowns and expensive rebuilds. Irving Subway Grating Co., Inc.

Circle E14 green card, last page

Bar Stock Valves Have Plastic Pointed Stems

A new 270 Series bar stock line of small valves features a choice of either long-wearing Nylon or corrosion-resistant Kel-F plastic pointed stems. The new plastic stem points offer many advantages over metal, particularly in the area of maintenance, since over-torqueing cannot damage the seat or stem point.

These new plastic tips have taken 700 cycles of operation at 3500 psi using twice the normal closing force, without leakage across the seat. They meet applicable military specifications for valves used on high pressure compressors, and provide vapor or vacuum leak-tight closure, with minimum opening pressure surges.

Maximum pressure rating of the 270 Series with plastic stem points is 5000 psi. The plastic tips are available on ⅛-inch and ¼-inch valves, and there is also a choice of either O-ring stem seal or Teflon packing. All valves can be panel mounted. Hoke, Inc.

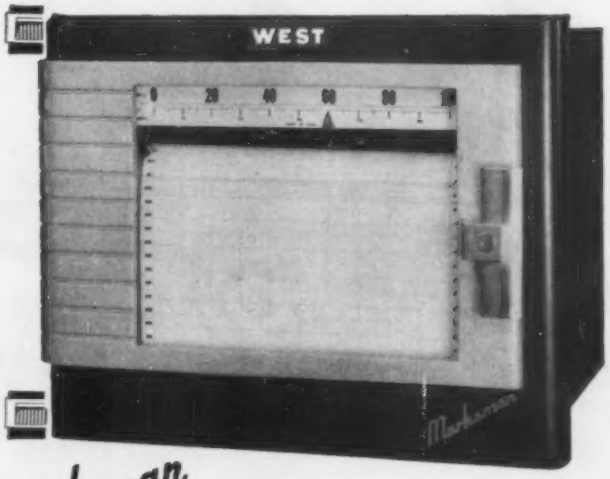
Circle E15 green card, last page

Self-Contained Power Pack For Remote Valve Control

An electro-hydraulic power package unit which operates valves in any remote location and at any distance from the control point is the latest addition to a line of automatic valve equipment. The unit operates piston valves of from 2½ inch to 8 inches and might be used for other valves of suitable construction. It is completely self-contained and need only be connected to an electricity supply to become operable. It can therefore be used in the most remote locations, provided only that a suitable electricity supply is available. It is so constructed that it can be used in any position—upright, horizontally or upside-down. The electric and hydraulic parts are housed in dust-proof compartments.

The power package unit is rated at 1 kilowatt, and operates at 220-volts single phase or 400-volts 3-phase to produce a force of about five tons. The unit is controlled by a 24-volt 15-milli-amp current

how many?



Marksman **RECORDERS by WEST**

Now in full production, these completely new tubeless potentiometer strip chart recorders are ready to go to work for you.

Get these features in all standard models at no extra cost:

- Transistorized Amplifier
- Printed Circuits
- Dial 5 Chart Speeds
- Chart Tearoff Strip
- Automatic Standardization
- Standardizing Indicating Light
- Built-in Chart Saver
- Plug-in Construction
- Separate Chart Re-Roll Motor
- Infinite Resolution Slide Wire
- Eleven Inch Calibrated Chart Width
- Will Mount in 19 Inch Relay Rack

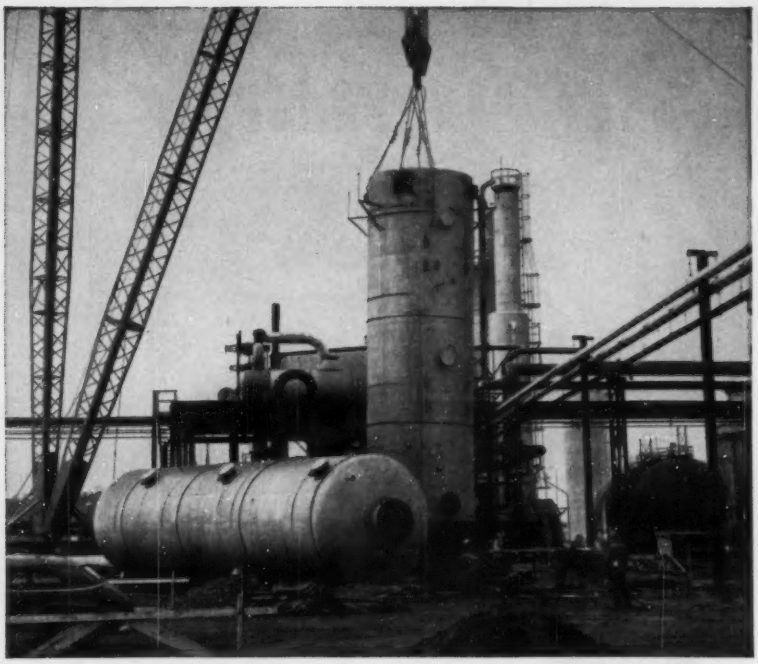
Yours are ready! For data or demonstration, write for Bulletin M or phone your West representative listed in the Yellow Pages.

WEST *Instrument* **CORPORATION**
SALES OFFICES IN PRINCIPAL CITIES
FACTORY AND GENERAL OFFICES:
4357B W. Montrose, Chicago 41, Ill.
BRITISH SUBSIDIARY:
WEST INSTRUMENT, LTD.
52 Regent St., Brighton 1, Sussex
Represented in Canada By: Upton, Bradeen & James

the trend is to **WEST**

See us at the 13th Annual ISA Instrument-Automation Conference & Exhibit, Sept. 15th-19th, Philadelphia, Pa., Booth #1332

For more data on advertised products, use Readers' Service Cards, last page.



More than 86,680 welds in complex column by Downingtown

Diameter: 11′ 11″ I.D.

Total Height: 93′ 11″.

Material: Stainless steel, Type 304. Carbon steel skirt and base ring.

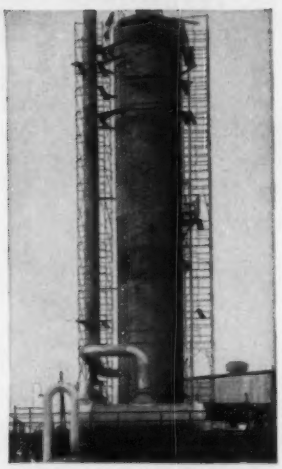
Shell Thickness: ½″ and ⅜″.

40 Trays and downcomers. 177 bubble caps and risers on each tray.

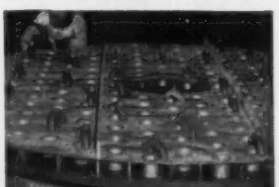
Code Stamping: National Board and ASME. Sandblasted and pickle washed.

Downingtown welders completed more than 86,680 separate stainless steel welds during fabrication of this stainless steel column. Tolerances of ±⅛″ . . . ±1/16″ . . . even ±1/32″ . . . were maintained in the shaping, positioning and welding of thousands of stainless steel parts. Lapsed time from drawing board to final field testing: less than six months.

Send for Bulletin PF. It tells the story of Downingtown skill and experience that enable us to breeze through complex fabrication jobs like this one.



Field tested by Downingtown... inspected by customer and Hartford... Code stamped on location.



Special jig for welding stainless steel risers to stainless steel tray.

Downingtown Iron Works, Inc.

151 Wallace Ave., Downingtown, Pennsylvania

division of PRESSED STEEL TANK COMPANY Milwaukee

Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

New Equipment . . .

from a control desk or by other electronic means.

Speeds of opening and closing can be regulated independently; the minimum time for one stroke of an 8-inch double-beat valve is 10 seconds, and 11 seconds for a 6-inch valve. Maximum stroke is about 5 inches. A feature of the equipment is that it locks the valve in any position by means of an auxiliary hydraulic valve. Richard Klinger, Ltd.

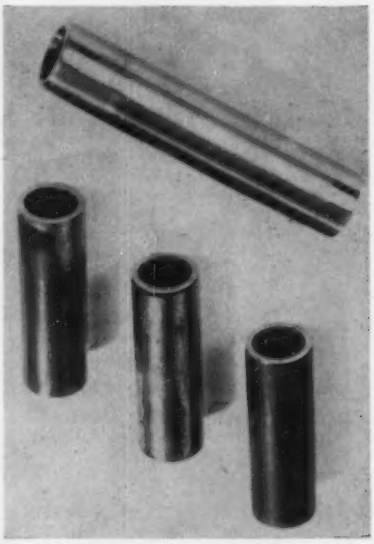
Circle E16 green card, last page

Steam Bypass and Trap Now Available As Combined Unit

A revolutionary new product for use where bypass piping is required, has just been introduced.

Having to make only 2 joints, where in a conventional steam trap bypass arrangement a minimum of 24 joints would have to be made, immediately illustrates the labor cost saving features of this unit. Velvan Steam Specialties, Inc.

Circle E17 green card, last page



Wax-Base Rust Preventive Gives Better Protection

These photographs of coated carbon steel tubing illustrate the superior protective properties of the new microcrystalline wax base rust preventive with inhibitor added. The bottom, coated with the wax base preventive, shows no signs of rust after six weeks' exposure to fumes from an acid house. The rusted sample at left above was uncoated and the two to the right of it were coated with ordinary rust preventives. All were exposed for a six weeks' period.

In addition to ability to give better,

longer-lasting protection, the rust preventive can be removed as simply and quickly as lighter, less efficient coatings. Maximum immersion time of five minutes in any of a variety of standard cleaners—such as kerosene, trichlorethylene or hot commercial alkali cleaners—will easily remove the wax coating. Dipping the bundle of tubing several times in the cleaning solution, with intermittent soaking, will speed the process.

The wax-base material has several other properties which make it desirable for use as a rust preventive. It is non-staining and is not slippery or messy to handle. It is non-irritating to the skin. It is reasonably attractive in appearance and is transparent so that the fabricator can see the condition of the metal under the coating. Finally, it is economical enough to permit its use without affecting tubing prices. Superior Tube Company.

Circle E18 green card, last page

Plastic Selection For All Corrosion Problems Given

Bulletin C-15 describes the selection of the proper plastic for each and every chemical corrosion problem. Such fields as the physical properties, chemical resistance, and typical equipment applications of phenolic, furane, polyvinyl chloride, polyester glass and tetrafluorothylene plastics are covered concisely and thoroughly with tables, pictures, diagrams and descriptions.

With this manual, it is possible for the engineer to select and specify the correct corrosion resistant plastic equipment to meet any situation. This bulletin is based on the work and findings of the company's field engineers over the last 25 years. Haveg Industries, Inc.

Circle E19 green card, last page

Leakproof Gate Valve Incorporates Teflon Seals

A new leakproof gate valve which incorporates Teflon seals in the wedge has now been placed on the market. Tradenamed the "Wedge-Seal" by the manufacturer, this new valve marks a radical departure from conventional gate valves. As the wedge is lowered in the new valve to a precision metal-to-metal fit against the seats, the Teflon seals on either side of the wedge compress against the seats to form a double sealing action. This double sealing action enables the "Wedge-Seal" valve to provide a positive shutoff both upstream and downstream, eliminating the need for a double block and bleed in piping installations.

In addition to its excellent sealing action, the "Wedge-Seal" is extremely practical to service with the valve in the line. Eventual seal replacement is simple to accomplish.

The "Wedge-Seal" is available in both 150 and 300 pound classes. Remote control "Wedge-Seal" valves are also available. Hammer Valves, Inc.

Circle E20 green card, last page

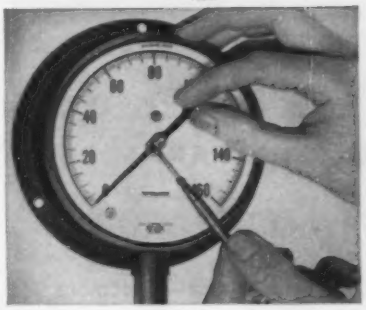
Industry Lab Facilities Described In 6-Page Folder

A six-page folder describing the complete laboratory facilities now available to the industry at Mixco is available free from the company. A special section is devoted to the new hazardous materials laboratory.

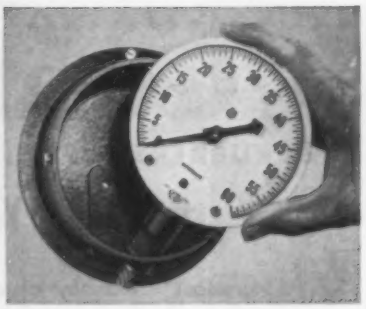
The folder outlines the pilot-plant mix-

SAVINGS IN MAINTENANCE TIME ALONE PAY FOR EVERY SUPERGAUGE IN YOUR PLANT

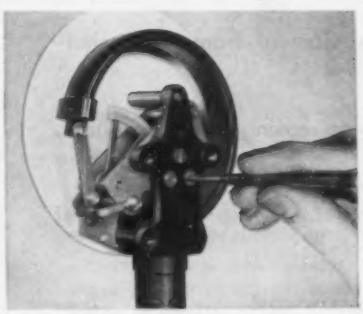
For example, with USG's exclusive Arc-Loc movement and Mono-Unit construction, complete recalibrations can be made up to 15 minutes faster than with any other process gauge. Here's why:



NOTE that with Supergauges, adjustments for "zero shift" can be readily made from the front, with gauge in operating position and without removing pointer from the shaft. Location of positive, self-locking worm adjustment screw on *side* of pointer prevents axial distortion of pointer or bending of shaft during adjustment.



NOTE that with USG Mono-Unit design, all Supergauge internals are integrated into a single assembly which can be removed in one quick operation. Complete legends on laminated plastic dials give gauge model number and materials used in construction of components for instant identification. More maintenance minutes saved!



NOTE that with USG's patented Arc-Loc movement, corrections for "scale shape" (linearity) errors and "range" adjustments are both made from the rear. No time is wasted in having to remove the pointer and dial. Each adjustment is a simple screwdriver operation; no special tools are required. In addition, USG's unique locking method eliminates creep during locking, further speeding recalibration time.

AND NOTE ESPECIALLY...

Supergauges meet ASA specifications for Grade AA Test Gauges, including accuracy within ½ of 1% of scale range. They are available in a full line, embracing a wide selection of case styles (including aluminum), case sizes, pressure ranges and materials of construction.

A companion line of SOLFRUNT (solid front construction) gauges is also available with the same fine USG features.

For complete information on SUPERGAUGE and SOLFRUNT process gauges, contact your local USG Distributor, or write for Catalog 1819.

UNITED STATES GAUGE
DIVISION OF AMERICAN MACHINE AND METALS, INC., SELLERSVILLE, PA.

USG

Are Entrainment Losses Stealing Your Profits?

Centrifix®

SCRUBBERS • PURIFIERS • SEPARATORS

Increase Your Profits!

1. Increases efficiency of existing equipment—get *more* production PLUS valuable by-products that help pay for this improvement.

2. Removes 99.5% or more of ALL solid or liquid entrainment in gas, air, steam or vapor regardless of density, chemical characteristics or size (even 1 micron or smaller).

3. Protects valuable capital equipment from costly shutdowns and major overhaul.

4. Reduces maintenance cost—no moving parts, no filters, non-clogging, self-cleaning.

5. Operates with MINIMUM pressure drop regardless of pressure, temperature or flow rate.

6. Easy to install—saves space, low cost.

AA-8246

FOR THE FINEST IN PURIFYING EQUIPMENT FOR STEAM-VAPOR-GAS-AIR

Centrifix® CORPORATION

3608 PAYNE AVENUE

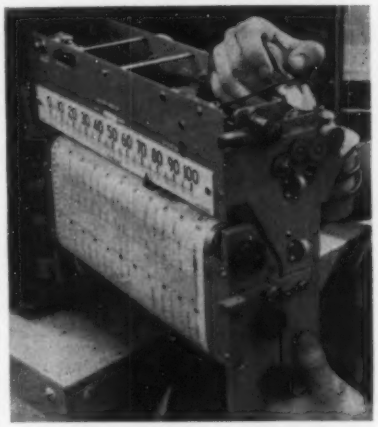
CLEVELAND 14, OHIO

All Centrifix equipment is protected by U. S. Letters Patent & Patents Pending

New Equipment . . .

ing operations of the hazardous materials laboratory and describes the unique uses of the new continuous multistage contactor. General information is given on industrial mixing research and studies at Mixco. Seventeen photographs show laboratory equipment in use. Mixing Equipment Co., Inc.

Circle E21 green card, last page



Recording Potentiometer Has Complete Flexibility

A new multipoint recording potentiometer is shown in the final stages of mechanical adjustment. A Heath resistance decade (on top of the recording potentiometer) is used to simulate multiple poltage inputs for checking the printing operation of the instrument.

A completely new approach to the design of multiple point recorders was considered and resulted in a design which offers complete flexibility in varying the number of points to be monitored, desired ranges and types of thermocouples. Any of these factors can be changed at will by the operator of the equipment using simple quick-change, inexpensive parts.

Should the instrument be measuring, for example, six points, and additional work load requires that twelve points be under scrutiny, the operator need only change a plug-in unit and replace a dial indicator and print wheel which are mechanically geared with the selector switch. No new selection switch is needed, no soldering is required, and no refitting of the components is necessary. The entire changeover operation can be completed in three minutes. Daystrom, Inc.

Circle E22 green card, last page

Life Comparisons Given In Wrought Iron Bulletin

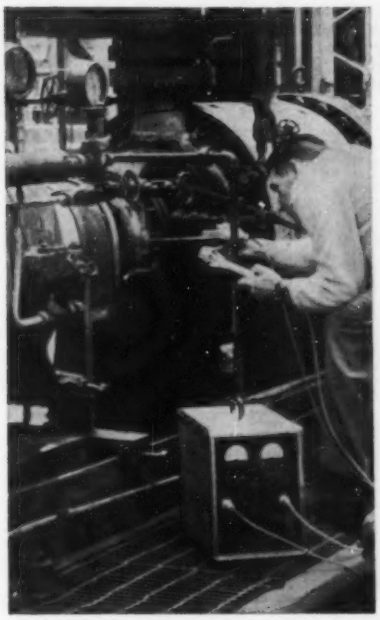
A new technical bulletin "Cold Drawn Wrought Iron Heat Exchanger and Condenser Tubes" has just been prepared. The ten-page booklet cites actual installations in which the use of wrought iron and other metal tubing in the same equipment permits service life comparisons. Listed are cost-per-foot-per-year figures for each material and the corrosive conditions to which the tubing was subjected in ice plants, hotels, industrial plants, and utility companies.

The booklet explains wrought iron's use in the heat exchanger and condenser tub-

ing replacement market, and why it is being used now in original heat transfer equipment.

A table of wrought iron tube sizes, along with calculated weights, internal and external working pressures and the over and under O. D. tolerances are shown. A. M. Byers Co.

Circle E23 green card, last page



Instrument Finds Vibration Troubles In Record Time

In refineries, as in all other continuous flow processing industries, one of the major problems is to maintain the machinery in constant smooth running condition. A sudden machinery failure can cause havoc to the production schedule. Furthermore, when a failure occurs, the trial and error method of determining the cause can create more havoc because it is time consuming and inaccurate.

An example of this is the case of a low pressure turbine driving an axial flow compressor; the turbine was part of a system processing 6000 barrels of gasoline per day.

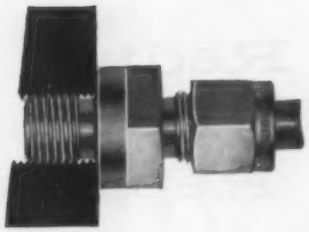
The turbine was taken out of service for excessive vibration; the rotor was balanced in a balancing machine and replaced in the turbine; the excessive vibration still persisted. The rotor was balanced again and returned to the turbine, with the same excessive vibration. This entire procedure required an unscheduled two weeks shut-down and a loss of 6000 barrels per day.

It is apparent now that the cause of vibration was not the rotor itself but was created by an associaed turbine component.

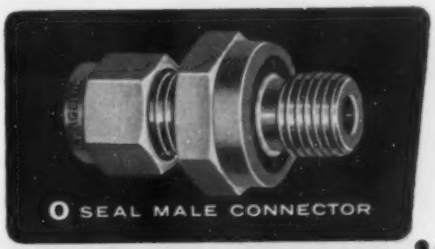
At one time, this type of problem would have kept on requiring production time until the men would have stumbled on the exact cause. But now, the electronic industry has come forth with an instrument which can pinpoint the cause of failure in a matter of minutes. Furthermore, this instrument can also balance rotating components of machinery in-place without costly dismantling of machinery.

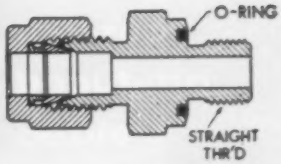
When this portable instrument came in to the refinery, the maintenance men were

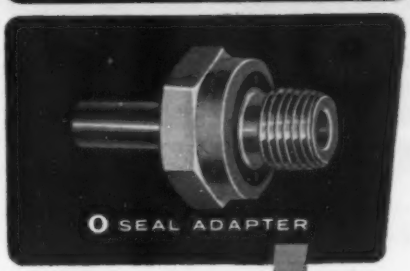
Eliminate even minute leakage

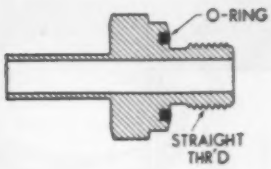


in critical applications with









Swagelok®

O seal fittings

Swagelok O Seal Fittings, with straight machine threads, eliminate every possibility of leakage that usually accompanies the use of ordinary taper pipe threads.

Swagelok O Seal Fittings are completely assembled, ready for immediate use. The O ring seal is held in the body of the fitting and a variety of O ring materials for specific applications is available.

Installation of Swagelok O Seal Fittings is simple. Just drill and tap — no counterboring or port contour cutting necessary. The use of messy pipe dopes or sealants of any kind is completely eliminated.

Screw in Swagelok O Seal Fitting, tighten and the installation is complete. A pressure or vacuum seal can be obtained against any flat surface.

A wide variety of connections is possible thru the use of Swagelok O Seal Adapter.

Swagelok O Seal Fittings are available in all machinable metals and plastics in tube O. D. sizes from 1/16″ thru 1″.

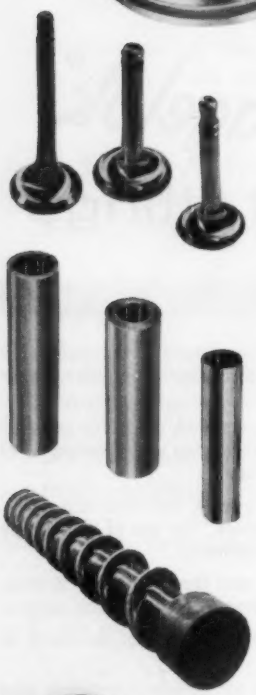
For name of your local Swagelok Distributor, write Dept. D5

CRAWFORD FITTING COMPANY 884 East 140th Street, Cleveland 10, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

Reduce Equipment Downtime And Replacement Costs

...with CLEVELAND custom produced welded Hard-Faced components



- Resistant to Wear, Corrosion and High Temperature
- In All Stainless Steel and Ferrous Alloys

Welded super alloy overlays applied only to critical areas subject to corrosion, erosion, abrasion, heat, thermal shock or impact, provide superior surface properties and precision finishes.

Whatever the size or shape, the metal overlay can be fused to all stainless and ferrous alloy O.E.M. and worn equipment at low cost.

For practical, prompt assistance on your application, send in your blueprint or call on our trained specialists.

Write for detailed literature

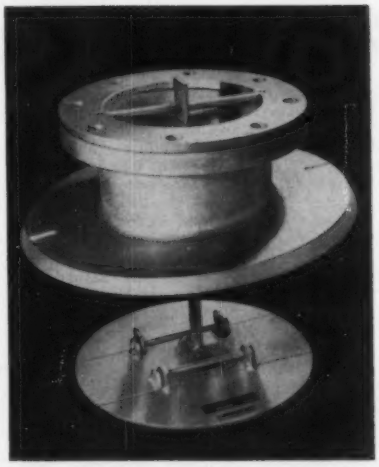
Cleveland Hard Facing, Inc.
3047 STILLSON AVE. • CLEVELAND 5, OHIO

New Equipment...

able to quickly determine that the excessiv vibration was caused by the coupling; the coupling was balanced in-place which required a few hours and without costly dismantling.

Using portable instruments to trouble-shoot and measure vibration, and to dynamatically balance, in-place, is a fairly new concept. The instrument used in this case is an IRD Vibration Analyzer. International Research & Development Corp.

Circle E24 green card, last page



Mechanical Device Reduces Tank Evaporation Losses

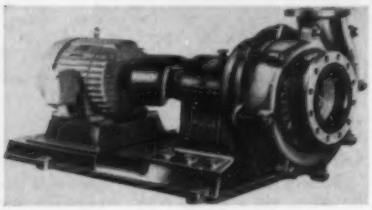
A new mechanical device, placed beneath the vent pipe inlet of gasoline storage tanks has been tested and proved to greatly reduce evaporation loss. Called the Air Baffle, this device consists of a horizontal flat plate mounted in alignment with the vent pipe inlet, far enough below the inlet so as not to impede ingress of air. Air Baffle is designed and constructed for easy, quick installation on tanks in service. It minimizes the downward velocity of air entering the vapor space through the breather vent, thus materially reducing one of the forces tending to accelerate evaporation. The device changes such downward flow of air to a substan-

For more data on advertised products, use Readers' Service Cards, last page.

tially horizontal direction, minimizing a force that causes movements of vapor. During "in-breathing," stratification of the fresh air above the heavy vapors, assures a reduction in evaporation and expulsion of the lighter vapors first during "out-breathing." By reducing the movement of such currents, Air Baffle affects economies through reduced vapor loss.

The unique advantage of the unit is in the fact that it may readily be installed on tanks in service. Engineering ingenuity has produced a collapsible design that permits simple insertion through the inlet opening. Once in position, a slight tilting action drops open the plate, achieving a flat horizontal disc below the roof opening. Shand and Jurs Co.

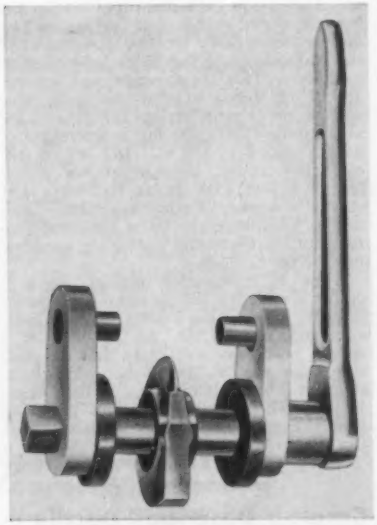
Circle E25 green card, last page



Acid Pump Handles 3,000 GPM With 8-Inch Discharge

The addition of a new 8-inch discharge size centrifugal pump to a well known line of Model "AF" Acid Pumps has just been announced. The new acid pump handles capacities to 3,000 gallons per minute. The complete line of "AF" acip pumps now includes 1-inch to 8-inch discharge sizes with 10 gpm to 3000 gpm capacities and heads up to 200 feet. A. R. Wilfley & Sons, Inc.

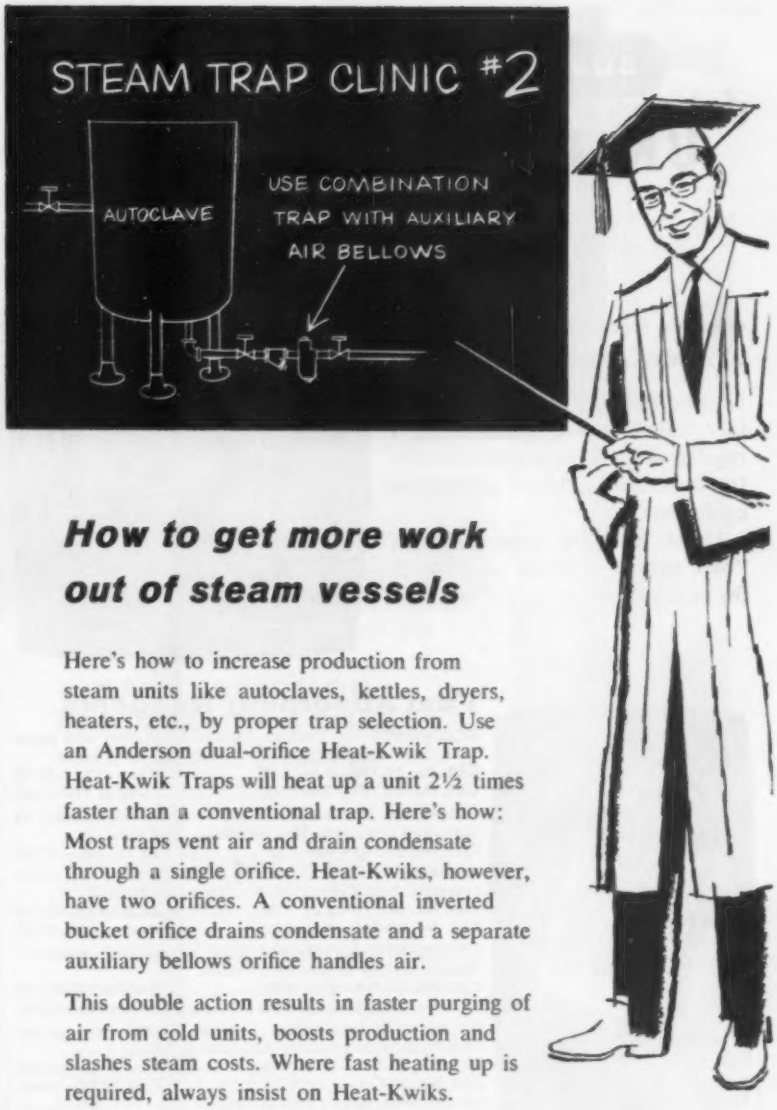
Circle E26 green card, last page



New Tool Makes Easy Job of Spreading Flanged Pipe

An entirely new and different tool for spreading flanged pipe connections—to insert gaskets, orifices, etc.—is now being manufactured and marketed.

This tool has been most appropriately named "Safety Boy" because, by its use, flanges can be spread safer, faster and more economically. "Safety Boy" elimi-



How to get more work out of steam vessels

Here's how to increase production from steam units like autoclaves, kettles, dryers, heaters, etc., by proper trap selection. Use an Anderson dual-orifice Heat-Kwik Trap. Heat-Kwik Traps will heat up a unit 2½ times faster than a conventional trap. Here's how: Most traps vent air and drain condensate through a single orifice. Heat-Kwiks, however, have two orifices. A conventional inverted bucket orifice drains condensate and a separate auxiliary bellows orifice handles air.

This double action results in faster purging of air from cold units, boosts production and slashes steam costs. Where fast heating up is required, always insist on Heat-Kwiks.

ANDERSON HEAT-KWIK STEAM TRAPS

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

Please send information on how to get more heat from steam units with your Heat-Kwik Traps.

Name _____ *Title* _____

Company _____

Address _____

City _____ *Zone* ___ *State* _____

Heats Up Production Units 2½ Times Faster

For more data on advertised products, use Readers' Service Cards, last page.

BURRELL "For Scientists Everywhere"

UNIFORM SOLUTIONS
For Gas Analysis

always fresh and active
. . . order as you need

Modern Burrell Reagents and Auxiliary Solutions are available as a regular, dependable source of supply for use with all makes of gas analysis equipment.

Listed here are some perennial "best sellers." Tell us your needs for prompt service.

Fast Absorbing Reagents

COSORBENT® for Carbon Monoxide. Active and accurate. Forms stable compound. Requires few passes.
CAT. No. 39-720—8 oz. 5.50.....Case of 12—59.40
CAT. No. 39-721—3 oz. 3.00.....Case of 12—32.40

COSORBENT POWDER for Carbon Monoxide. Easier to store and transport. Has indefinite shelf life.
CAT. No. 39-725—vial 3.50.....Case of 12 vials—37.80

LUSORBENTⓉ for Unsaturated Hydrocarbons. No vapor pressure. Non-Corrosive to rubber connections.
CAT. No. 39-715—8 oz. 4.00.....Case of 12—43.20
CAT. No. 39-716—3 oz. 2.50.....Case of 12—27.00

OXSORBENT® for Oxygen. Fast, clean and accurate. Breaks sharply at saturation point.
CAT. No. 39-710—8 oz. 5.50.....Case of 12—59.40
CAT. No. 39-711—3 oz. 3.00.....Case of 12—32.40

DISORBENTⓉ for Carbon Dioxide. Crystal clear potassium hydroxide solution. Accurate and fast.
CAT. No. 39-730—16 oz. 3.00.....Case of 12—32.40
CAT. No. 39-731—3 oz. 1.75.....Case of 12—18.90

®Trademark Registered U.S. Patent Office ⓉTrademark

NOTE: Order 8 oz. for each charge in a standard absorption pipette; 3 oz. for Industro® gas analyzers.

Specifics for Hydrocarbons

SORBENT "A"Ⓣ—For total olefins, ethene, propene, butene and pentenes.
CAT. No. 39-741—8 oz. 4.50.....Case of 12—48.60

SORBENT "B"Ⓣ—For selective absorption of iso-butene. Takes up 1-butene and 2-butene slowly.
CAT. No. 39-742—8 oz. 2.75.....Case of 12—29.70

SORBENT "C"Ⓣ—For propenes, butenes and pentenes. Will absorb ethene slowly.
CAT. No. 39-743—8 oz. 2.75.....Case of 12—29.70

SORBENT "D"Ⓣ—For acetylenes and higher members of the acetylene series.
CAT. No. 39-744—8 oz. 6.00.....Case of 12—64.80

ⓉTrademark

Prices listed are F.O.B. Pittsburgh, Pa.

Ask for Bulletin No. 327

BURRELL CORPORATION
Scientific Apparatus and Laboratory Supplies
2223 FIFTH AVENUE, PITTSBURGH 19, PA.

New Equipment . . .

nates all the old and hazardous methods of spreading flanges.

A patented feature of this new tool is a circular cam wedge. This feature, plus the use of a ratchet handle, provides pipefitters with a lightweight, handy-to-carry tool that will spread a flange in a matter of seconds.

Operation of the tool is fast and simple. First, all flange bolts are loosened and necessary bolts removed. The tool is anchored onto flanges by insertion of pins into flange bolt holes while at the same time inserting tapered edge of circular cam wedge into small opening between flanges. Pressure easily applied by ratchet handle quickly spreads flange connection.

"Safety Boy" is especially useful in a minimum working space. Wm. L. Riggs Co.

Circle E27 green card, last page

Boiler Designed To Burn Cat Regenerator Waste Gas

Boilers for burning carbon monoxide gas in refineries are described in a 20-page catalog just issued, entitled "C-E Boilers for Catalytic Regenerator Waste Gas." The catalog explains design features of these boilers which are intended to recover both chemical and sensible heat from refinery waste gas. Cutaway views of construction features and tangential burners are included along with four pages of engineering data on waste fuel products. Combustion Engineering, Inc.

Circle E28 green card, last page

MI Cable Approved For Use In Hazardous Locations

Type MI mineral-insulated cable with special Type H explosion-proof fittings has been accorded recognition for use in hazardous locations by interim amendment of the National Electrical Code, effective immediately. This supplements and extends 1953 Code recognition of this same cable with Type O terminations for general use at a continuous operating temperature of 85 C. (185 F.); 250 C. (482 F.) in special applications. Because of the prevalence of low flash point solvents and vapors in many industrial operations classified as hazardous, the latest approval contemplates a maximum operating temperature of 85 C. (185 F.).

Type H terminating fittings are generally similar to the present well-known Type O terminating fittings, and the sealant contained within the pot seal is a special new solvent-resistant material well suited for use in Class I hazardous locations. It is more than adequate for Classes II and III hazardous locations involving explosive dusts and flyings. General Cable Corp.

Circle E29 green card, last page

Catalog Describes Ductile Iron Pipe Lock Couplings

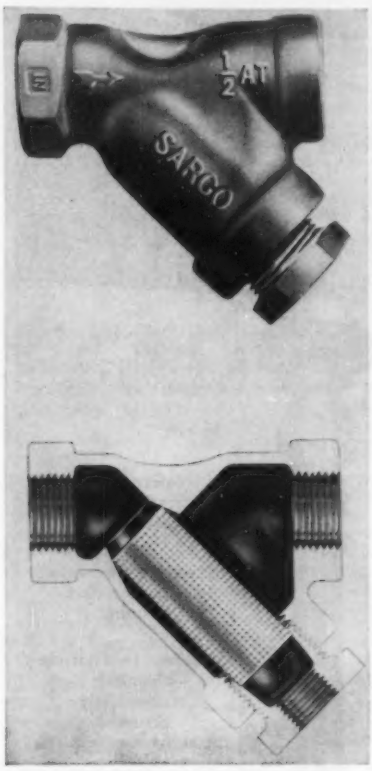
A four-page catalog describing the "K" series of ductile iron pipe lock couplings has just been released.

Catalog PL-1 lists the specific cost-saving advantages of these ductile iron fittings, the pressure ratings for various sizes as listed by Underwriters' Laboratories, Inc., illustrations of how to install the fittings and recommendations for their use. The catalog also contains price lists

and size information for installing with schedule 40 steel pipe.

The fittings are available in two weights: 800-D (heavy) and 400-D (light). The Kuhns Brothers Co.

Circle E30 green card, last page



High Strength Pipe Line Strainers, Self-Cleaning

A new line of semi-steel, self-cleaning pipeline strainers in sizes from one-fourth inch through three inches has just been announced for availability in late fall.

Features of this new strainer, type AT, are the high strength construction of the semi-steel (ASTM-A48-48, class 30) bodies, internal design that insures tight fit of the screen cylinder without buckling, perforated heavy gauge screen with spot welded lap seams that insure maximum rigidity with smooth inner surfaces, and built-in sediment collection chamber integral with cap. The 45F design facilitates clearing by blow-off. Every strainer is hydrostatically tested and is rated for saturated steam or liquids to 250 psi and 475 F. total temperature. Sarco Co., Inc.

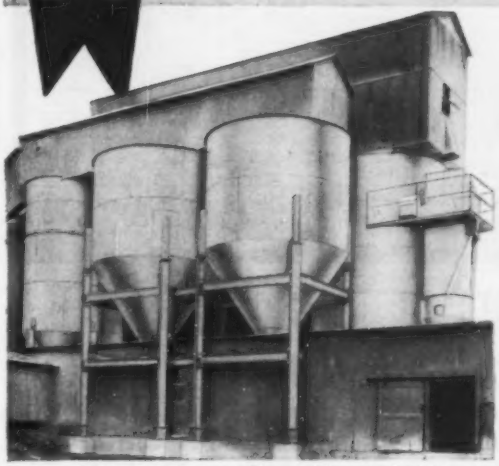
Circle E31 green card, last page

Gasoline Additive Protects Copper With Coating

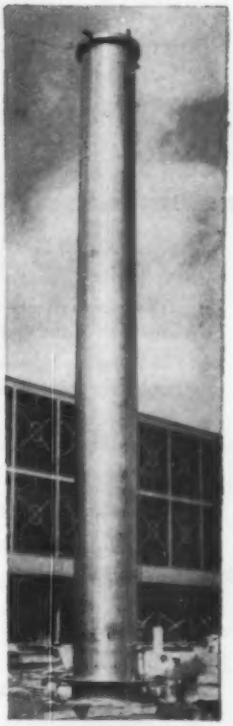
A new compound that provides an effective chemical coating on metal surfaces containing copper, thereby promoting gasoline stability and retarding formation of gum and insoluble residues, now is available in experimental quantities.

Currently identified only by the experimental number PL-297, the new product is expected to find widespread use as an additive for gasolines used in vehicles which are stored for extended periods, in marine fuels, and many other applications where gasolines are in contact with large

77 years of KOVEN fabricating experience built into every Job



Field erected storage bins Stainless Steel Clad



Stainless Clad Smoke Stack 7'0" x 80'0" High

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; large diameter fabricated piping and plate exhaust ducts; shop and field erected storage tanks; high vacuum testing.

SPECIALISTS IN INTRICATE FABRICATION USING:

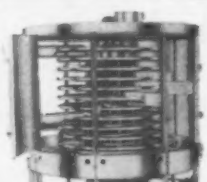
STAINLESS STEEL • ALUMINUM • MONEL NICKEL • INCONEL • ALL CLAD MATERIALS NICKEL PLATED STEEL • JOB GALVANIZING STRESS RELIEVING

Fabrication to all A.S.M.E. Codes

Call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550.

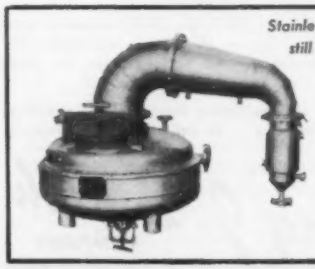
Members of Steel Plate Fabricators Association

SEE SWEET'S FILE AND CHEMICAL ENGINEERING CATALOG



Dryer made of stainless steel and aluminum

Stainless steel jacketed still with downpipe



80' Dia. Clarifying Tank—Field Erected

Koven FABRICATORS, INC

91 E. Dickerson St., Dover, New Jersey

PLANTS JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.

Telephone:
New York: WOrth 4-7395
New Jersey: FOxcroft 6-0400

For more data on advertised products, use Readers' Service Cards, last page.

Here is the capacity range of Purolator lube grease filters...

ELEMENT SPACING	MICRON EQUIVALENT	CAPACITIES IN GPM VISCOSITIES IN SSU WATER 30	100	300	700	1000	3000
.001	25	53	31	18	12	10	6
.0015	37.5	76	44	26	17	14	8
.002	50	97	56	33	21	18	11
.003	75	133	77	46	29	25	14
.005	125	190	110	65	42	36	21
.007	175	194	112	66	43	37	21
.008	200	207	120	71	46	39	23
.010	250	230	133	79	51	44	25
.015	375	230	133	79	51	44	25
.020	500	200	116	68	44	38	21

NOTE: Flow rates are based on clean fluid at 1 PSI initial pressure drop. To approximate the flow of 1 PSI in SCFM for air, nitrogen, or similar gases, multiply the flow in GPM at 100 SSU by 4.

. . . and here are the advantages:

- It's easier to change the Purolator element between batches. Handles are attached to the specially constructed screw-on case.
- Cleaning the element is fast, easy and thorough; simply rotate the element, manually or mechanically, against a fixed knife blade.
- Filtration is dependable and accurate because this filter uses Purolator's Metal Edge principle, a tight durable coil of precisely spaced metal ribbon.
- The filter is designed specifically for batch filtration of greases.

For more specific information contact Purolator Products, Inc.

Filtration For Every Known Fluid

PUROLATOR
PRODUCTS, INC.
RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

Quoth Sir Galva-Knight:

ANOTHER WEAPON AGAINST CORROSION!

METALLIZING

Metallizing joins with hot-dip galvanizing in preventing corrosion. The Nowery J. Smith Company, already the South's largest commercial hot-dip galvanizing concern, now offers a complete, expert metallizing service as well. This means that units too massive for hot-dipping can be provided with a tough armor-coating of zinc or aluminum and these applications can be performed in the shop, in the field — even on offshore location!

Write today for descriptive literature and specifications on metallizing . . . or call UN-9-1425, Houston.

Nowery J. Smith COMPANY

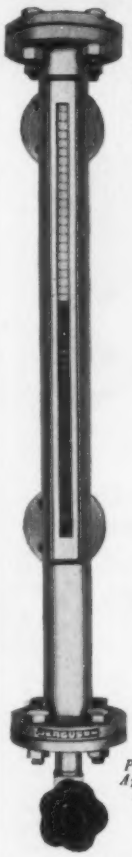
one of the SMITH *Southwest Serving the Southwest*

Commercial Galvanizing
Pickling, Oiling, Metallizing, Sandblasting,
Prime coating, and / or painting.

8000 Hempstead Hwy., P. O. Box 7398, UNderwood 9-1425, Houston 8, Texas

---

Announcing
the New
Jerguson
MAGNETIC GAGE
For Liquid Levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

Available with electric alarms.

Patent Applied For

Can also be used for interface indication.

Write now for engineering sheet on Jerguson Magnetic Gages.

JERGUSON
Gages and Valves for the Observation of Liquids and Levels
JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
In Canada: Peacock Bros. Ltd.

See Booth 1671—ISA Show

New Equipment . . .

areas of copper, or subjected to unusually severe oxidizing conditions. It also may be of value in fuel oils, certain types of lubricating oils, and other hydrocarbons where it is desirable to eliminate harmful catalytic effects of copper or copper bearing alloys.

Laboratory tests indicate the new compound is remarkably effective in suppressing the pro-oxidant effects of metallic copper and copper alloys. Its ability to coat copper surfaces is said to be a unique performance quality not exhibited by conventional metal deactivators which function principally by deactivating solved or soluble copper. E. I. du Pont de Nemours & Co.

Circle E32 green card, last page

Girbotol Gas Purification Described In New Booklet

Performance data and photographs of typical industrial applications, of the "Girbotol Gas Purification Process" are outlined in a new illustrated booklet now available.

Applications listed for the widely-used Girbotol amine gas purification process include natural gas purification, refinery gas purification, synthesis gas purification, carbon dioxide recovery, hydrogen sulfide recovery, liquid hydrocarbon desulfurization, hydrogen purification and inert gas preparation. The chemistry and basic flow diagram of the process are presented. Girdler Construction Div., Chemetron Corp.

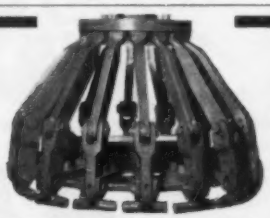
Circle E33 green card, last page

Condensed Catalog Covers 95 Percent of Co.'s Valves

The Ohio Injector Company has published a new condensed version of its General Catalog which lists its complete line of industrial valves.

Now available for distribution, this catalog lists over 95 percent of the line, condensed into 28-page form. Valve figure numbers are indexed for finger-tip reference by topics; face to face dimensions are supplied in full size ranges.

The condensed version lists for the first



BARRETT automatic

Filling and Crimping Equipment

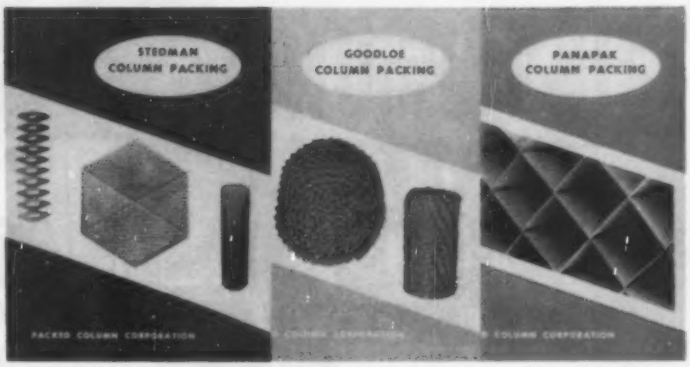
for handling greases and other viscous fluids.

- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

Now—for *Low-Cost* plant use



LOWEST COMMERCIAL H.E.T.P. — **STEDMAN**
LOWEST PRESSURE DROP — **GOODLOE**
HIGHEST CAPACITY — **PANAPAK**

Bulletins and Additional Information on Request

PACKED COLUMN CORP.

PACKED COLUMN CORPORATION
30 Church Street, New York 7, N. Y.
A Column Packing For Every Application

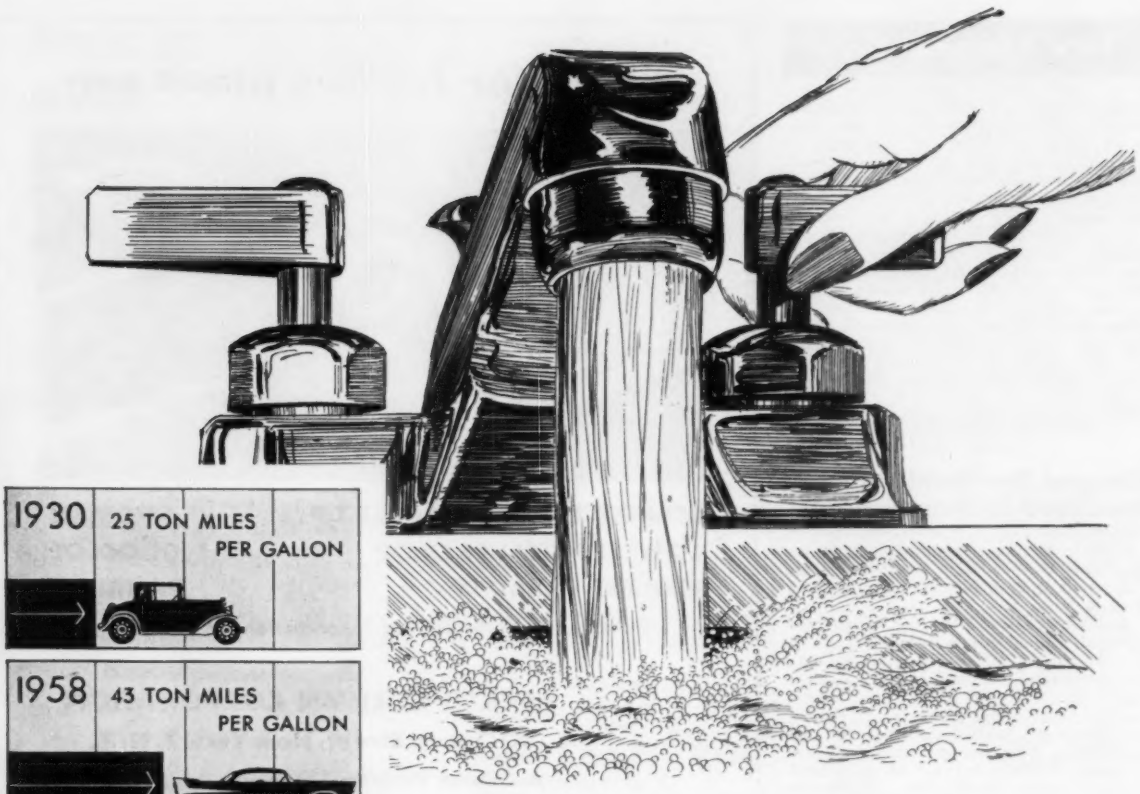
for heavy duty service

ROCKWELL "WAFER" VALVES

Wafer valve with air motor operator. *Right*—rubber-lined wafer valve with hand wheel control.

Compact, space-saving butterfly valves for dependable throttling and wedge-tight shut-off of air, gas, liquids and semi-solids at differential pressure to 150 psi and temperatures from minus 50° to plus 600°F. and higher. Manual or automatic operators. Standard sizes to 36" and larger special sizes. Write for Bulletin 580.

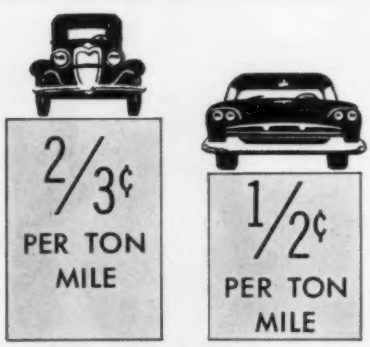
W. S. ROCKWELL COMPANY
2368 ELIOT STREET • FAIRFIELD, CONN.
Sales Representatives in Principal Cities



Today's gasoline has far more value. An accurate way to measure this value is by "ton-miles"...the number of miles a gallon of gasoline will move a ton of car. Average performance in 1930 was 25 ton-miles per gallon. Today it's 43 — or 70% more work per gallon.

Can you think of any liquid that costs less than gasoline . . . except water?

Quart for quart, gallon for gallon, almost any liquid you buy costs more than gasoline . . . and gasoline performance today costs less than it did in 1930.



Fuel cost per ton mile is down 18% since 1930. To move a ton of car a mile took ⅔¢ worth of fuel. Modern gasolines move today's heavier cars a ton-mile for about ½¢. When you remember you are buying performance, gasoline costs less today than in 1930.

In spite of higher operating costs in the oil industry, gasoline prices have been held down through research and intense competition. Since 1930 the price of gasoline (excluding taxes) rose only 23%. During the same period the general cost of living went up 70%.

The taxes on a tankful of gasoline would buy between four and five extra "tax-free" gallons. Combined state and federal taxes, which help pay for better roads, add about 9¢ to the price of every gallon . . . nearly 30% of your gasoline dollar buys no gasoline at all.

STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment...

time a section on bronze brazed joint valves as well as its corrosion resistant nickel-iron line. A forged and cast steel section has been developed showing complete valve trim designations and pressure temperature charts with ratings to latest ASA specs.

Valuable supplementary information is contained in a valve comparison chart which offers a quick cross reference to the most commonly used figure numbers of ten valve manufacturers. The Ohio Injector Co.

Circle E34 green card, last page

Watertight Condulet Is Safe from Hose Wash Down

A new line of watertight (NEMA 4) and weather resistant junction Condulets, Series WJB, suitable for both indoor and outdoor use has been introduced. Electrical wiring inside the Condulet is protected, even when the area is washed down with a hose. A round Neoprene gasket prevents water from entering. Body is outside flange design, with four cast mounting feet.

Three sizes are available: 4 inches, 6 inches, and 8 inches in width. Walls can be drilled and tapped for conduit up to 2 inches, and brazed hubs can be added for larger sizes. Crouse-Hinds Co.

Circle E35 green card, last page

Bulletin Describes Medium Pressure Screw Compressor

A new bulletin covering the medium-pressure line of Spiraxial Compressors presents design and construction data as an aid to proper selection and application of this equipment in a wide range of process industries.

The bulletin presents the full range of capacities from 1,000 cfm to 12,000 cfm for pressures up to 15 psig. This model (designated LAH) fills out the Spiraxial line, supplementing the model (designated LAL) for pressures up to 30 psig. Seventeen sizes are listed in the bulletin, with ratings and capacities for each unit included in a selection table. These capacities can be increased almost indefinitely by combining a series of compressors into multi-stage units. Roots-Connersville Blower.

Circle E36 green card, last page

DAVIS INSTRUMENT DIVISION *AND* **GREENBRIER INSTRUMENTS INC.**

Present a complete line of

CHROMATOGRAPHIC INSTRUMENTS

for Laboratory and Industrial Process Stream Analysis and Control

A complete line of instruments utilizing AIR, as the carrier gas. **NO HELIUM REQUIRED!**

Write for Technical Bulletins.

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS
Division of
Davis Emergency Equipment Co., Inc.
164 Halleck St., Newark 4, N. J.

GREENBRIER INSTRUMENTS INC.
P.O. Box 382
Ronceverte, West Virginia

CUT COSTS 4 WAYS

with **AURORA®** *End-Suction Centrifugal* **PUMPS**

AURORA TYPE BCH

EXTREMELY HIGH EFFICIENCY
Required head and capacity delivered with lower HP motors. Saves space, saves initial outlay, saves operating costs.

LOW NPSH CHARACTERISTICS
Saves head room where critical suction conditions exist.

LONGER TROUBLE-FREE OPERATION
Better construction, finer materials keep lines operating for less cost.

FASTER MAINTENANCE WHEN NEEDED
Exclusive features enable easy disassembly without disturbing pump-motor alignment or discharge piping.

SEND FOR BULLETIN 119-C

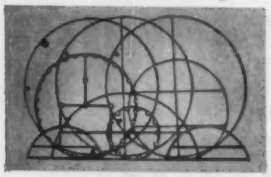
AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY

84 LOUCKS STREET • AURORA • ILLINOIS
EXPORT DEPARTMENT—Aurora, Illinois—Cable Address "NYABINT"

For more data on advertised products, use Readers' Service Cards, last page.

GASKETS
For Every Purpose



HEAT EXCHANGER GASKETS

Made in any size or shape needed in double jacket type. Also cut from solid metal or sheet packing. Write for Bulletin 564.

CORRUGATED METAL GASKETS

Plain or jacketed type. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel and monel in all sizes and shapes. Write for Bulletin 565.

PROMPT DELIVERIES

CHICAGO-WILCOX MFG. CO.

7719 So. Avalon Ave., Chicago 19, Ill.

GUNITE

Since 1915

CONCRETE

SAND AND CEMENT "Placed by Air"

GUNITE

BLO-CRETE **WET-CRETE**

LINING, ENCASING, FIREPROOFING, REPAIRING

Send for our new bulletin No. 20 of actual photographs, information and detailed specifications.

GUNITE CONCRETE & CONST. CO.

1301 WOODSWETHER RD., KANSAS CITY 5, MO.
2016 W. Walnut St., Chicago 12, Ill.
1004 Market St., St. Louis 1, Mo.
3206 Houston Ave., Houston 9, Texas
1136 W. Orangethorpe, Fullerton, Calif.
Milwaukee—Twin Cities—Denver—New Orleans

REFRACTORY HAYDITE

Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.

We sell direct to you.

CONSTRUCTION MATERIALS
CARTER-WATERS
KANSAS CITY MISSOURI

2440 Pennway Phone GRand 1-2570

Advertisers in This Issue

PETROLEUM REFINER, September, 1958

* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1958 Refinery Catalog.

A

*ACF Industries, Inc. 47, 361
*ADSCO Division
Yuba Consolidated Industries, Inc. 109
*Aerofin Corp. 68
*Aerovent Fan Co.
Large Propeller Division 491a
*The Air Preheater Corp. 168
*Airetool Manufacturing Co. 375
Allied Chemical—Nitrogen Division 80
Allied Chemical Corp. 129, 212, 360
Alloy Steel Products Co. 169
The Allpax Co. 380
*Aluminum Company of America 114, 384
Amercoat Corp. 176
*American Air Liquide 143
American Bitumuls & Asphalt Co. 366
American Brake Shoe Co. 453
*The American Brass Co. 409
American Bridge Division
United States Steel Corp. 22-23
American Cyanamid Co.
Refinery Chemicals Department 355
*American Machine and Metals, Inc. 503
American Petroleum Institute 35
American Steel & Wire Division
United States Steel Corp. 382-383
*The V. D. Anderson Co. 507
Anemostat Corporation of America 381
The Annin Co. 418
Armstrong Machine Works 82
The Atlantic Refining Co. 49
Atlas Powder Co. 178-179
Audley Engineering Co. Ltd. 38L
*Aurora Pump Division
The New York Air Brake Co. 513b
Austin-Western, Construction Equipment Div.
Baldwin-Lima-Hamilton 174
*Autoclave Engineers, Inc. 173
Avondale Marine Ways, Inc. 483a

B

*B-I-F Industries, Inc. 2
*The Babcock & Wilcox Co. 115, 463
*Badger Manufacturing Co. 42-43
*Bailey Meter Co. 104
*Baldwin-Hill Co. 180
Baldwin-Lima-Hamilton
Austin-Western 174
Barber-Colman Co.
Wheelco Division 484
Barksdale Valves 477b
Barrett Manufacturing Co. 511a
Bethlehem Steel Co. 471
Betz Laboratories, Inc. 61
*Black, Sivalls & Bryson, Inc. 78
*Blaw-Knox Co. 97, 139, 449
*Bopp & Ruether G. m. b. H. 481b
Borg-Warner Corp. 434
*Bridgeport Brass Co. 487
The Bristol Co. 170-171, 447
*British Ermeto Corp., Ltd. 38Qb
*Buell Engineering Co. 8
Burrell Corp. 508
Byron Jackson Pumps, Inc. 434

C

*Calumet & Hecla, Inc. 437-440
*The Cape Asbestos Co., Ltd. 41
Carter-Waters Corp. 514c
Catalytic Construction Co. 29
*Catawissa Valve & Fittings Co. 376
*Causeway Reinforcement Limited 435
Centrifix Corp. 504
The Chapman Valve Manufacturing Co. 146-147
Chase Brass & Copper Co. 195
Chemetron Corp. 56
*Chemical Construction Corp. 34
Chempump Corp. 189
Chicago Bridge & Iron Co. 130
*Chicago Pneumatic 120-121
*Chicago-Wilcox Mfg. Co. 514a
*Chiksan Co. 79
*Childers Manufacturing Co. 60
Classified Advertising 485
Cleveland Hard Facing, Inc. 506
*The Cleveland Wire Cloth & Mfg. Co. 466a
Cockburns Ltd. 38Ra
The Colorado Fuel & Iron Corp. 403
Columbia-Geneva Steel Division
United States Steel Corp. 382-383, 445
Combustion Engineering Co. 124-125
Conax Corp. 479a
Conoflow Corp. 74
C. Lee Cook Co. 133
*The Cooper-Bessemer Corp. 100-101
Copon Associates 188
*Coppus Engineering Corp. 25
Crane Company 359
Crane Packing Co. 395
Crawford Fitting Co. 505
Crescent Insulated Wire & Cable Co. 477a
Crouse-Hinds Co. 197
W. H. Curtin & Co. 516a
*Curtiss-Wright Corp. 128

D

Dameron Enterprises, Inc. 479c
Davis Instrument Division
Davis Emergency Equipment Co. 513a
Davison Chemical Division
W. R. Grace & Co. 457
De Laval Steam Turbine Co. 181
Dempster Brothers 144
DeZurik Corp. 491b
*Dorr-Oliver, Inc. 140
The Dow Chemical Co. 149
Dowell 421
*Downingtown Iron Works, Inc. 502
Doyle & Roth Manufacturing Co. 482
*Dresser Industries, Inc. 45
*The Ducon Co. 419
E. I. du Pont de Nemours & Co. 141-142, 202
*The Duraloy Co. 452
*Durametallic Corp. 466b

E

*E. C. D. Limited 38N
The Eagle-Picher Co. 182
*Eastern Industries, Inc. 99
Eastman Chemical Products, Inc. 91
Electro-Alloys Division
American Brake Shoe Co. 453
Ellerbee Brothers 117
*Elliott Co. 84-85
Emco Brass Mfg. Co. Ltd. 38Qa
*Engineers & Fabricators, Inc. 151
*Enjay Co. 70
Ethyl Corp. 204-205
Ever-Tite Coupling Co. 444a
Evershed & Vignoles Ltd. 38K

F

Fairbanks, Morse & Co. 28
Felker Brothers Manufacturing Co. 134
Ferro Corp. 389
Fish Engineering Co. 404
*Fisher & Ludlow Limited 38E
*Fisher Governor Co. 32, 137
*Flexitallic Gasket Co. 372
Flexonics Corp. 372, 408
*Flint Steel Corp. 185
The Fluor Corp. 377
*Food Machinery & Chemical Corp. 156
The Foram Corp. 483b
*Forge and Fittings Division
H. K. Porter Company, Inc. 470
Benjamin Foster Co. 488
*Foster Wheeler Corp. 111, 183
The Foxboro Co. 184
Frick Co. 515b

G

Gardner-Denver Co. 426
*The Garlock Packing Co. 145
*General American Transportation Corp. 159
General Chemical Division
Allied Chemical Corp. 212
General Controls Co. 118
*General Electric Co. 416-417
Girdler Construction Division
Chemetron Corp. 56
Claud S. Gordon Co. 515a
*Goulds Pumps, Inc. 148
W. R. Grace & Co.
Davison Chemical Division 457
*Graham Manufacturing Co. 123
*Graver Tank & Mfg. Co. 4
A. P. Green Fire Brick Co. 44
Greenbrier Instruments, Inc. 513a
*Grinnell Co. 194
*The Griscom-Russell Co. 196
*The Gulf Publishing Co. 38Rb, 151, 451b, 451c
Gunite Concrete & Const. Co. 514b
Gustin-Bacon Mfg. Co. 378-379
Gutehoffnungshutte 483b

H

*Hamer Valves, Inc. 499
Hammel-Dahl
Division General Controls Co. 118
*Harbison-Walker Refractories Co. 369
*The Harshaw Chemical Co. 30-31
Head Wrightson & Co. Ltd. 38J
*Hendrick Manufacturing Co. 33
*Homestead Valve Mfg. Co. 17
Houdaille Industries, Inc. 423
Houdry Process Corp. 367
*Howe-Baker Engineers, Inc. 103
*Hudson Engineering Corp. 36-37

I-L

Independent Engineering Co. 422

Continued on Page 516

SERV-RITE DRILLED WELLS

thermometer sockets
thermometer test wells
thermocouple wells

FOR PLUS SERVICE

SERV-RITE drilled protecting wells are made in types, lengths, and of alloys to meet any temperature and pressure condition in vessels and flow lines.

Every well is carefully made to assure a plus service. Selected bar stock is machined to within accurate limits. Bore concentricity is held within 5% of wall thickness, depending on well length. They are tested to withstand pressures up to 3000 psi., depending on the wall thickness. Exterior surface has a mirror-like finish for minimum resistance to flow in lines.

Complete assemblies can also be furnished with suitable thermocouple, head, flange, fittings, etc.

Give SERV-RITE a trial on your next drilled well requirements. There is none better.

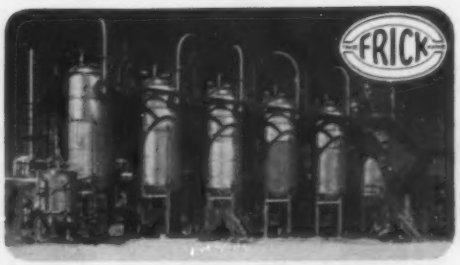
Write for Bulletin No. 2000
for specifications, size, and ordering information on SERV-RITE drilled wells.

8640

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

615 West 30th Street, Chicago 16, Illinois
2019 Hamilton Ave., Cleveland 14, Ohio

—NEW— GENERAL TIRE AND RUBBER CO. PLANT: Odessa, Texas



Frick Company furnished the twelve big reactors* illustrated, each 22 ft. high and equipped with a double set of Frick cooling coils*; plus coolers and evaporative condensers for butadiene, evaporative condensers for ammonia, and numerous auxiliaries.

Thus another great synthetic plant joins the list of firms using Frick cooling equipment.

Whatever the refrigerating requirements of YOUR plant—air conditioning, process cooling or condensing, cold water, ice making, quick freezing, cold storage, or low temperatures — Frick engineers will help you design a system to meet your needs.

Butadiene condensers at Odessa, Texas

Call your nearest Frick Branch, Distributor or write to.....

* Patented

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U. S. A.

YOU'LL FIND IT HERE!

BLINDS • SPACER RINGS • TEMPORARY and LINE STRAINERS • PIVOT FLANGES

MAC-IRON is the name on eight authoritative pages in the 1958 Refinery Catalog. You'll find specifications, descriptions, and data on equipment designed and constructed to function with extreme efficiency.

As specialists to the Petro-Chemical Engineering Field for many years *MAC-IRON* has developed skills and facilities which make possible a degree of design and production service seldom equalled. In the event of an emergency or tight schedule, *phone Sandusky MAin 6-3712* for immediate attention to your problem.

Refer to our pages and listings in Refinery Catalog or write direct for MAC-IRON CATALOG A-7. Your inquiry will receive prompt attention. Specific engineering data formulated on request.

"IF YOU USE PUMPS
You need MAC-IRON Strainers"

SANDUSKY MAC-IRON OHIO
ESTABLISHED 1901

THE MACK IRON WORKS COMPANY
121 WARREN ST., SANDUSKY, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

*Ingersoll-Rand Co. ..... 135, III Cover
*International Engineering, Inc. 478
The International Nickel Co. 150
*Irving Subway Grating Co. 441

Jefferson Chemical Co. 119
*Jerguson Gage & Valve Co. 510c
The Jet-Vac Corp. 402
Jo-Bell Products, Inc. 411
*Johns-Manville Corp. 12-13, 394
*Jones & Laughlin Supply Division 54-55

Kaiser Engineers 46
*The M. W. Kellogg Co. 207, 431
*Richard Klinger Ltd. 39
*Koch Engineering Co. 126
Koven Fabricators, Inc. 509

*Lake & Elliot Ltd. 38Pb
Langley Alloys Ltd. 38Mb
Lapp Insulator Co. 127
Lawrence Pumps, Inc. 474
Layne & Bowler, Inc. 199
Leeds & Northrup Co. 24
Lenape Hydraulic Pressing & Forging Co. 476
F. B. Leopold Co. 131
The Lincoln Electric Co. 472
Linde Company
Division Union Carbide Corp. 385, 443
Lukens Steel Co. 412-413
*The Lummus Co. 364-365, 468-469

M-P

*The Mack Iron Works Co. 515c
*Magnetrol, Inc. 497b
Maintenance Mechanical Corp. 464
Manning & Lewis Engineering Co. 492
Manning, Maxwell & Moore, Inc. 172, 465
Manufacturers Engr. & Equipment Corp. 516b
Manzel Division
Houdaille Industries, Inc. 423
*Jas. P. Marsh Corp. 153
*Mason-Neilan Division
Worthington Corp. 92-93
Arthur G. McKee & Co. ..... IV Cover
*Metal Processing Division
Curtiss-Wright Corp. 128
*Metal Propellers Ltd. 38Pa
*Metal Textile Corp. 497a
*Midwest Piping Co. 193
*Mine Safety Appliances Co. 122
*Minerals & Chemicals Corp. of America 20
Minneapolis-Honeywell 190-191
Missouri Boiler and Tank Co. 11
*W. K. Mitchell & Co. 94
*Mixing Equipment Co. 200
*Samuel Moore & Co. 214
*Murray Iron Works Co. 110
Mutual Chromium Chemicals
Solvay Process Division
Allied Chemical Corp. 129

Nash & Thompson Ltd. 38Ma
*National Airoil Burner Co. 480
National Aluminate Corp. 363
National Tube Division
United States Steel Corp. 86, 382-383
*National-U. S. Radiator Corp. 446
*New England Tank & Tower Co. 498
New England Valve Corp. 64
*The New York Air Brake Co. 513b
Newalls Insulation Co. Ltd. 40
W. H. Nicholson & Co. 152
*The C. W. Nofsinger Co. 456
*Nooter Corp. 415
*Norton Co. 48, 407

*OTM Corp. 370
*Oakite Products, Inc. 155
*Oil Well Supply Division
United States Steel Corp. 6
Okadee Co. 405
*Samuel Osborn & Co. Ltd. 38H

*Pacific Pumps, Inc. 45
Pacific Tube Co. 430
Packed Column Corp. 511b
Palmer Thermometers, Inc. 371
The Ralph M. Parsons Co. 410
*Patent Chemicals, Inc. 177
The Patterson Foundry & Machine Co.
Subsidiary, Ferro Corp. 389
Peerless Manufacturing Co. 83
*Peerless Pump Division
Food Machinery & Chemical Corp. 156
Pennsalt of Washington Division
Pennsalt Chemicals Corp. 458
Perkin-Elmer Corp. 459
*The Permutit Co.
Division Pfaudler Permutit, Inc. 157, 495b
*Petreco Division
Petrolite Corp. 98
*Petro-Chem Development Co. 50-51
*The Pfaudler Co.
Division Pfaudler Permutit, Inc. 454-455
*Phelps Dodge Copper Products Corp. 14-15
Phelps Dodge Refining Corp. 158
The Pipe Fabrication Institute 63
Pittsburgh Corning Corp. 166
*Pittsburgh-Des Moines Steel Co. 66-67
Plibrico Co. 427a
*H. K. Porter Company, Inc. 470
*Posey Iron Works, Inc. 481a
Horace T. Potts Co. 198
The Wm. Powell Co. 62
*The Power-Gas Corporation Ltd. 38C
Procon Incorporated 473
*Proportioneers Division
B-I-F Industries, Inc. 2
Purolator Products, Inc. 510a
The Pyle-National Co. 21
The Pyrene Company Ltd. 38F

Q-U

The Quaker Oats Co. 26

The Rackle Co. of Texas 73
*The Refinery Catalog 58-59
The Refinery Engineering Co. 52
*Republic Steel Corp. 432-433
Resistoflex Corp. 386-387
Reynolds Metals Co. 88-89
The Ridge Tool Co. 427b
*Rochester Manufacturing Co. 161
W. S. Rockwell Co. 511c
*Rockwell Manufacturing Co. 397-400
*Rockwood Sprinkler Co. 163, 475
Royal McBee Corp. 493

*Sarco Co. 428-429
Scam Instrument Corp. 96
*Schutte & Koerting Co. 495a
*Scovill Manufacturing Co. 71
*Selas Corporation of America 424-425
Shand & Jurs Co. 116
Shell Development Co. 72
*The Nowery J. Smith Co. 510b
Smithco Engineering, Inc. 65
Solvay Process Division
Allied Chemical & Dye Corp. 129, 360
Sparkler Manufacturing Co. 160
Speedline Stainless Steel Fittings Division
Horace T. Potts Co. 198
Standard Brass & Mfg. Co. 494
Standard Oil Company of California 512
Standard Oil Company (New Jersey) 461
Stauffer Chemical Co. 76-77
*Strahman Valves, Inc. 420
*Stratford Engineering Corp. 90
*Strong, Carlisle & Hammond 500
*Struthers Wells Corp. 87
*Sun Shipbuilding & Dry Dock Co. 164
Sunvic Controls Ltd. 38G

*Taylor Instrument Companies 186-187
Tellepsen Petro-Chem Constructors 95
Tennessee Coal & Iron Division
United States Steel Corp. 382-383, 445
*Tennessee Corp. 495d
*The Terry Steam Turbine Co. 165
Texas Instruments, Inc. 450
Thermon Manufacturing Co. 368
John Thompson (Dudley) Ltd. 38A
Timken Roller Bearing Co. 16
*Tretolite Co. 57
Tri-State Oil Show 451a
Triangle Valve Co., Ltd. 38
Truland Chemical Co. 102

*Union Asbestos & Rubber Co. 162
Union Carbide Corp. 385, 443
Union Wire Rope Corp. 192
United States Gasket Co. 406
*United States Gauge Division
American Machine & Metals, Inc. 503
United States Pipe & Foundry Co. 112-113
*United States Rubber Co. 357
United States Steel
Corp. 6, 22-23, 86, 175, 382-383, 445
United States Steel Export Co. 382-383, 445
United States Steel Supply Division 382-383, 445
*United States Stoneware Co. 53
*Universal Atlas Cement Co. 175
Universal Oil Products Co. 18-19, 401

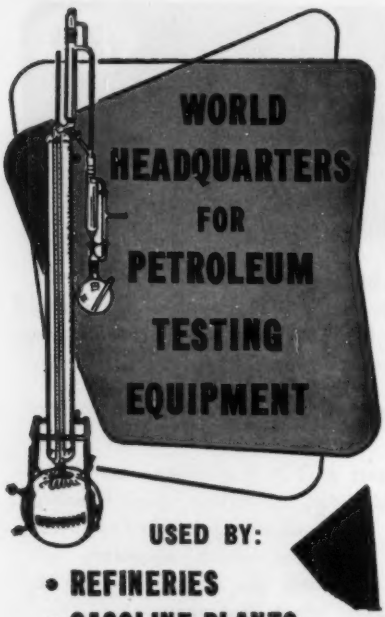
V-Z

Visco Products Co. 69
*Henry Vogt Machine Co. 27
Vokes Gensprings Ltd. 38D
*J. H. H. Voss Co. 444b

*W-K-M Division
ACF Industries, Inc. 47, 361
Wagner Electric Corp. 167
Walsh Refractories Corp. 496
Walworth Co. 138
Warren Petroleum Corp. 390
Washington Aluminum Co. 495c
West Instrument Corp. 501
Western Supply Co. 75
Wheelco Division
Barber-Colman Co. 484
The Whiton Machine Co. 448
Wickwire Spencer Steel Division
The Colorado Fuel & Iron Corp. 403
*The Gustav Wiedeke Co. 436
A. R. Wilfley & Sons, Inc. 81
T. D. Williamson, Inc. 132
Wilmad Glass Co. 490
*Thomas C. Wilson, Inc. 136
*Wolverine Tube Division
Calumet & Hecla, Inc. 437-440
Woodfield Rochester Limited 38B
Worcester Valve Co. 388
*Worthington Corp. 92-93, 105-108
Wright-Austin Co. 479b

*Yarnall-Waring Co. 208
*Otto H. York Co. 210
*Yuba Consolidated Industries, Inc. 109, 489

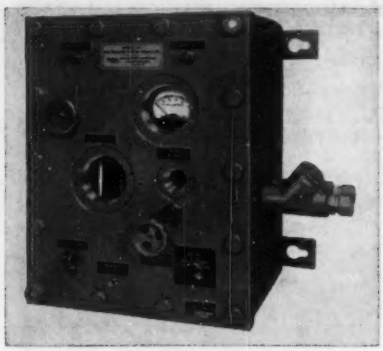
*Zallea Brothers 467
*John Zink Co. 460



USED BY:

- **REFINERIES**
- **GASOLINE PLANTS**
- **PETROCHEMICAL PLANTS**

W. H. CURTIN & CO.
DOMESTIC EXPORT · Established 1922
LABORATORY APPARATUS, FURNITURE & CHEMICALS
Houston · Dallas · New Orleans
Jacksonville · Mexico City



Model W Electrolytic Moisture Analyzer
Explosion-Proof Model

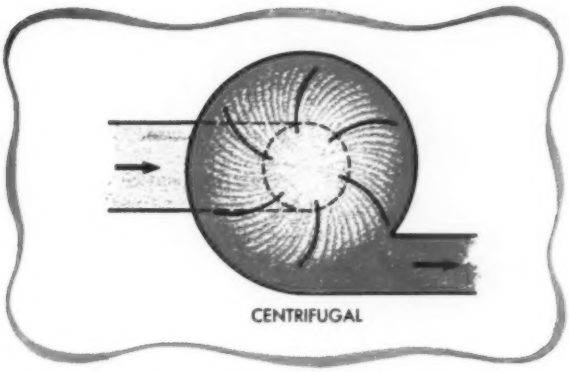
Measures water content better than 1 part per 1,000,000!

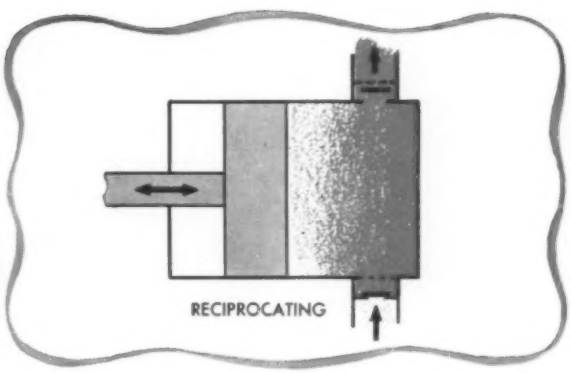
Some Useful Applications:

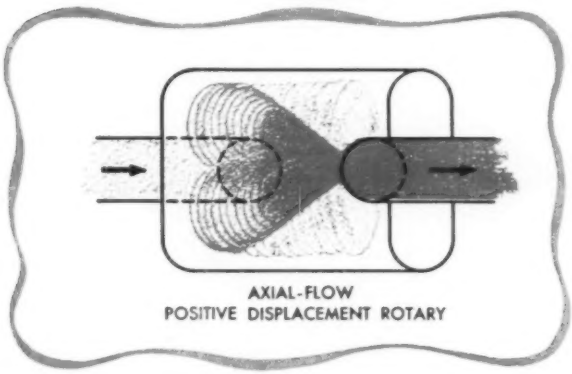
- Continuous or batch analyses of water in a wide variety of gas and liquid streams—including process streams, inert atmospheres required in plant processes and laboratory dry boxes, and plant instrument streams.
- Measuring reaction rates where water is involved as a reactant, product, or catalyst.
- Studies of moisture permeability of polymers.

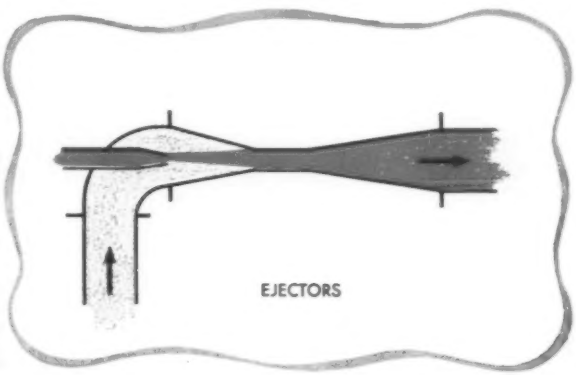
Write for complete information

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
Hatboro · Pa.







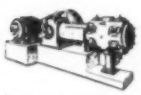


Which method is best for your PRESSURE or VACUUM requirements?

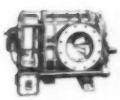
AIR or any other gas behaves differently under each of these methods of compression or evacuation. But for any set of operating conditions, *one method* will have advantages that make it the most practical and economical solution to the problem.

Ingersoll-Rand, the only manufacturer of *all four types* of compressors, is in a unique position to help you select the most efficient unit for any job. Here are a few general comments on each type.

Centrifugal Compressors. Ingersoll-Rand centrifugal blowers and compressors are available in single- and multi-stage units, for handling large volumes of air and all other gases at vacuum and for pressures up to 2500 psi and higher. Sizes range up to 20,000 hp and capacities to 300,000 cfm. They can be driven by steam turbine, electric motor, combustion-gas turbine and hot-gas expander turbine.



Reciprocating Compressors. I-R reciprocating compressors are available in single- and multi-cylinder designs to meet a wide range of high-pressure, low-volume requirements. They have been furnished in sizes from ½ to 7,500 hp, for pressures to 35,000 psi and vacuums. Driver types may be electric, steam, oil or gas, and oil-free air can be provided by means of Type NL non-lubricated cylinders and valves.



Axi-Compressors. The Ingersoll-Rand Axi-Compressor is a compact, space-saving axial-flow positive displacement rotary compressor that offers unique advantages within its operating range. It delivers a steady flow of clean, oil-free air or gas and can be direct driven by electric motors or gasoline engines. Available in capacities from 100 to 12,000 cfm for pressures to 15 psi and vacuums to 15″ hg. Higher vacuums can be produced with water injection or with two stage units.

Ejectors. For many applications, I-R ejectors offer maximum simplicity and economy, as they have no moving parts and require practically no attention or maintenance. They can be supplied for vacuums to 5 microns (0.000197″ hg abs), as well as for pressures to 150 psig.

• • •

Your Ingersoll-Rand representative will be glad to give you complete information on any of these compressor or vacuum units — and help you select the one that's best suited to your particular requirements.

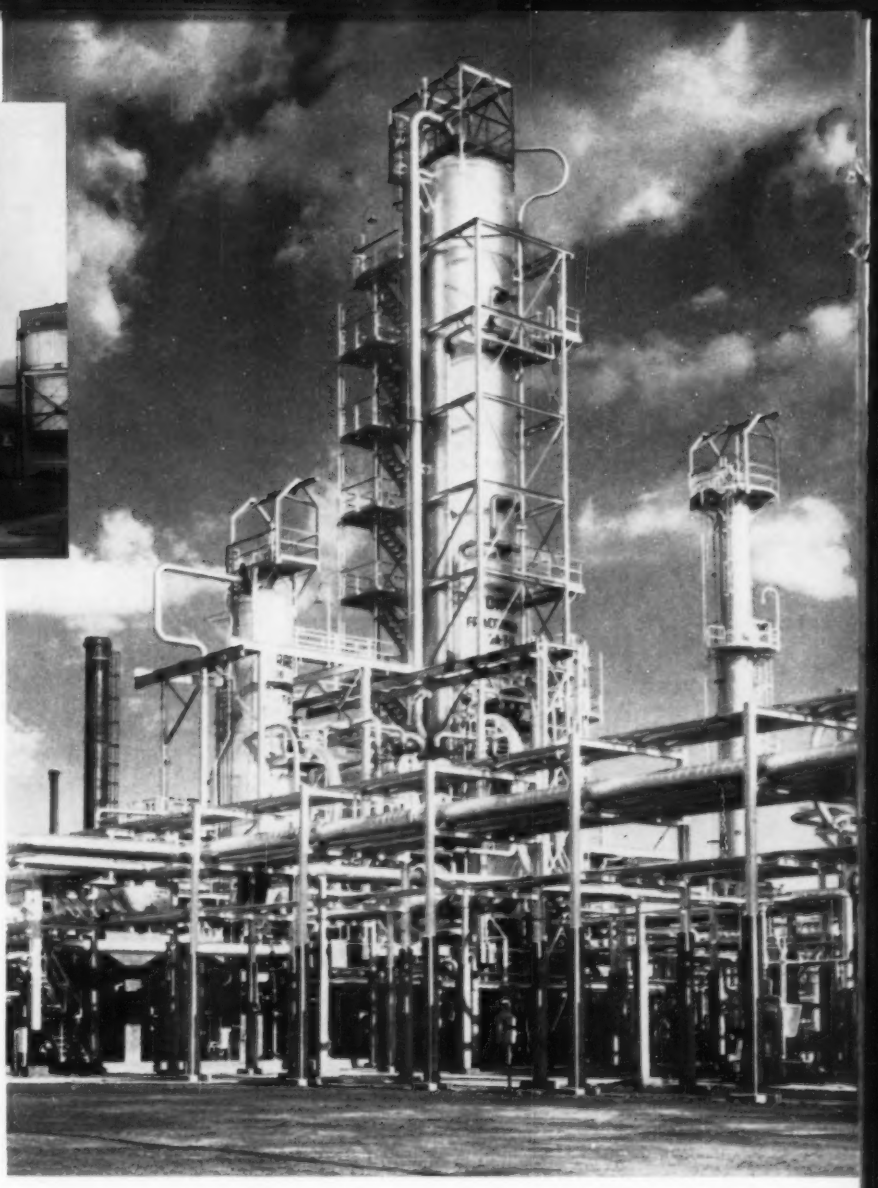
Ingersoll-Rand IR

14-867 11 Broadway, New York 4, N. Y.

There's no substitute for experience in engineered products

PETROLEUM REFINERY—CIRCA 1865

This Cheese Box Still was a "large-scale" refinery in the early days of petroleum, employing the most up-to-date process known at that time.



PETROLEUM REFINERY—1958 STYLE

The brick foundations and chimneys of earlier days have long since given way to the modern design and construction seen in this atmospheric crude distillation unit.

McKee is now building one of the largest, if not *the* largest crude processing unit in the world. With a capacity of 140,000 barrels-per-stream-day, it will be capable of processing twice as much crude in a year as *all the wells in America* produced in the first ten years of the industry's history.

The Profit-Making Life of a Refinery depends on its *ENGINEERING*

McKEE builds plants that are designed and constructed to earn profits for years to come. McKee engineers have no magic ability to *see* into the future, but they *do* have the ability to *plan and build* for the future. Basically, this is the result of two things: constant improvement of design techniques and construction methods; and a half-century fund of practical, world-wide experience upon which to draw.

We believe it will pay you well to consult McKee on your new plant project or plant expansion program.

McKee
ENGINEERING & CONSTRUCTION
Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, N. J. • Houston, Tex. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto